PUBLIC WORKS

Founded in 1896

Devoted to the interests of the engineers and technical officials of the cities, counties and states

VOL. 71. NO. 12

Coming Next Month

In addition to a number of excellent articles on Sewerage and Water Works, the January 1941 issue of PUBLIC WORKS will celebrate the 38th Annual Convention of the American Road Builders Association with the following group of top notch articles on Highways for Defense:

HOW NATIONAL DEFENSE WILL AFFECT HIGHWAY CONSTRUCTION
By R. E. ROYALL

BOTTLENECKS AND HOW TO ELIMINATE THEM
By BERNARD E. GRAY

ACCESS ROADS
By GEORGE MARTIN

WIDENING AND STRENGTHENING BRIDGES
By E. E. BRANDOW

EQUIPMENT FOR RAPID CONSTRUCTION OF BITUMINOUS ROADS
A Staff Article

WIDENING SHOULDERS
By EARL B. LOCKRIDGE

Whether he attends the ARBA meeting or not, everyone interested in streets and roads will find these articles of unusual interest and value.

A. PRESCOTT FOLWELL, Editor

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Christmas Reflections

If nobody smiled and nobody cheered
And nobody helped us along,
If each minute looked after itself
And the good things all went to the strong,
If nobody cared just a little for you
And nobody thought about me,
And we stood all alone in the battle of life
What a dreary old world it would be.

Life is sweet because of the friends we have made
And the things which in common we share.
We want to live on not because of ourselves
But because of the people who care,
It's giving and doing for somebody else
On that all life's splendour depends,
And the joy of the world when it's all added up
Is found in the making of friends.

ANON.

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Landscaping at Fargo's Waterworks Plant.

Landscaping Fargo's Sewage Treatment Plant

F. W. PINNEY, Superintendent

Selection of trees and shrubs for both wind breaks and ornamental purposes, and four years' experience in raising them.

AT THE time the Fargo, N. D., plant was built, some money was set aside for landscaping the grounds. The grading around the buildings was completed in 1935, but it was not until the spring of 1936 that the landscape work was under way. Two of the local floral companies were given the job and a sketch of the grounds and the proposed plantings made and approved. The original plantings were made the last week in May.

Description of Plantings

Now for a rough description of the plantings. A hedge of buckthorn was planted four feet inside of the fence, along the east side of the grounds. It took 925 roots to fill this space. A row of American elms, ninety-three in all, were placed around the outer edge of the grounds and along the road leading into and around the plant. Three groupings of trees were planted, not only for wind breaks, but also for ornamental purposes.

One group was at the southwest corner of the grounds consisting of 88 Niobra willow, grouped along the west line fence north for a distance of about 225 feet.

The second group is on the east side of the sludge beds and south of the digesters and is composed of 35 Bolleana poplar for the background, and in front of these, 7 Austrian pine.

The third group is at the northwest corner of the filter where 25 Bolleana poplar were planted as a background and scattered in front; and to the east, 14 Black Hill spruce. Around the digesters and in front and on the east side of the grounds, 45 Black Hill spruce were planted along with 8 Colorado blue spruce and 5 Austrian pine.

Two groups of Mugho pine and Pfister juniper were planted on each side of the driveway leading into the Administration building, also a small group of pine and juniper at the southeast of the building. Grouped around the lift station and clarifier are beds of shrubs composed of spirea, mock orange, and Jap-

A view of Fargo's sewage plant.

anese barberry. East of the filter are two large beds of common lilac, golden elder, snowberry, and Japanese barberry. At the northeast and southeast corners of the filter, we have groups of Negro pine and Pfister juniper.

Austrian Pine Die

In the first planting, 1853 trees and shrubs were set out. Not all of these lived by any means, as we lost 10 to 15 per cent of the first year planting. The contractors replaced the trees that were lost the next spring, but in the replacements we decided to make some changes. The Austrian pine all died and were replaced with Black Hill spruce. The same thing happened with several of the Colorado blue spruce, which were replaced with Black Hill spruce.

We also have several beds of flowers around the buildings which we fill up with petunia, phlox, poppy, and hollyhocks which plants seem to stand up the best under the weather conditions and the bugs, which are an awful pest.

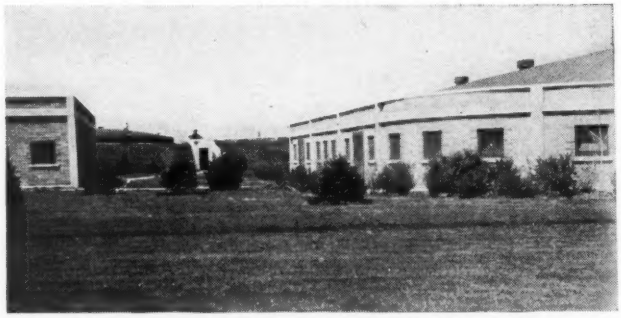
The Black Hill spruce seems to grow and do the best for us of the evergreens. We notice around the digesters where the trees are well protected from the northwest winds, that the trees do much better, grow faster, and are more bushy. We find that all evergreens have to be sprayed once or twice a year for red spiders. In fact, we spray all our trees, as well as all plants and shrubs.

Ash Seed Grow Well

Three years ago, we also planted two rows of ash seed across the northwest corner of our property and now have a real windbreak in the making. It's surprising the way these seed came up and the growth the trees are making. By the end of this season they will be three to five feet in height.

We would recommend spring planting for this country and plenty of water at the time of planting and every two weeks from then on. Also, give the trees and shrubs a top dressing of sludge. This sludge will hold the moisture and keep the weeds down. We installed our own pumping system, and use the filter effluent to water with. It takes lots of time and plenty of hard work on this landscaping, but we think the results warrant the effort put into the job. We receive many compliments from visitors, especially those from out of town.

This article is published through the courtesy of the North Dakota Water and Sewage Works Conference.



Fargo's sewage plant, showing clarifiers at right, digester in the center.

Health Conservation Contest

According to announcements received by Dr. R. H. Riley, Director of the State Department of Health of Maryland, several Maryland Counties have enrolled in this year's nation-wide rural health conservation contest—the seventh in the series conducted jointly by the Chamber of Commerce of the United States and the American Public Health Association.

For contest purposes the United States is divided into six geographic divisions—the Northeastern, Eastern, Southeastern, South Central, North Central, and Western divisions. Only those counties that meet certain requirements with respect to organization, personnel, and to specified services, are eligible to take part in the contest. The awards are based on the effectiveness with which a county is meeting its health problems and on permanent attainments in public health.

Similar contests are open to cities. The achievements of each city or county taking part are appraised by a committee of experienced health authorities. Advisory service is available from the American Public Health Association to participating health units, on request, in connection with the contest.

The purpose of the contest, as stated in the official announcement, is to further the development of sound public health work; to stimulate and promote needed improvement in community health services and to assist in the reduction of preventable illnesses and unnecessary deaths. Essential health services considered in grading the health units include the following:

Statistical: The completeness and accuracy with which records of births, deaths, and causes of death are kept and used as "yard sticks" in the program.

Communicable Disease Control: Percentage of children in younger age groups immunized against diphtheria; vaccinated against smallpox; measures for control of syphilis, and gonorrhea; for control of tuberculosis; for protection against other communicable diseases.

Services for Mothers and Young Children: Prenatal and obstetrical care; medical and nursing supervision of young children; infant and preschool services.

Health Services in the Schools: Medical examination of school children; follow-up home nursing visits; dental clinics; tests of vision; provision for safe water supplies; individual drinking cups; bubbling fountains in the schools.

Laboratory Services: To aid in the diagnosis of disease; for examination of water, milk and other foods.

Sanitation: Provisions for protection of water supplies from contamination; for adequate sewage disposal systems; public and private.

Sanitary Supervision of Milk Supply: Inspections of dairies and dairy products.

Participation of physicians and dentists in the general health program.

Health Education activities; and community participation in health services.

Maintenance Organization and Classification in Wayne County

Description of the work, separated into eight classifications, done by the Maintenance Division of the Board of Road Commissioners of Wayne County, Michigan.

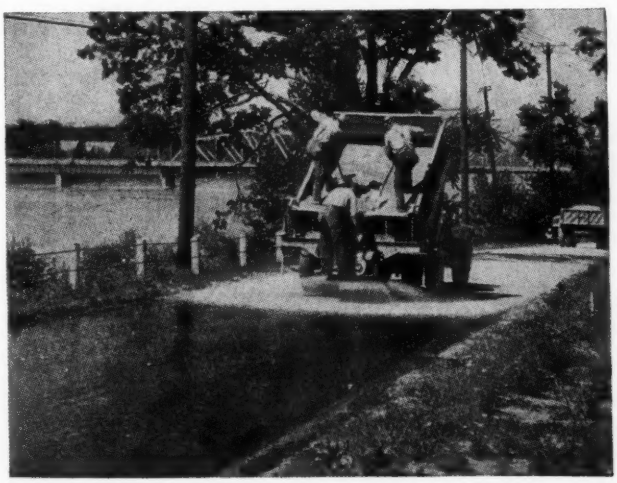
Wayne County direction signs.

THE maintenance division, Board of Road Commissioners of Wayne County, Mich. (of which Detroit is the principal city), is charged with the maintenance of all roads and streets under the jurisdiction of the Board. It is headed by the Maintenance Engineer, Richard H. Steketee; and under his direction the General Superintendent, Milford N. Brown, and his assistants carry out the work. To facilitate administration, the county is divided into six districts, with a foreman in charge of each. All equipment, such as trucks, graders, compressors, maintainers, cranes, mowers and other tools are distributed among these districts in accordance with the needs of the work; and as work is completed, equipment is moved to other locations as needed.

The maintenance work on roads and streets is separated into eight classifications as listed below in the annual report of the Board. Costs of doing the work are kept in accordance with these classifications as well as to the location of the roads.

Roadbed:

Under this heading is included all work pertaining to the maintenance of the shoulders, ditches and roadsides. Since drainage is most essential to a good road, surface water and ground water must be taken care of if the road is to give good service. Shoulders must be kept smooth and properly sloped if the surface water is to get to the ditches. The ditches, culverts, sewers and catchbasins must be kept clean so that the water can readily get to its outlet. This type of work is essential to prevent the roadbed, which is the foundation of the road, from becoming too soft to carry the loads.



West River Road on Grosse Ile just south of Bellevue Road. A chip spreader applying limestone chips after the application of an asphaltic seal coat.

Structures:

Culverts are necessary to carry ditches under the roadway. These must be of sufficient strength and width to carry traffic and with adequate capacity to permit the flood waters of the ditches to flow unimpeded. Constant inspection and repair work are necessary to keep many of the old structures performing properly.

Guardrails and guard posts are necessary to provide safety at dangerous places along the highway. They must be kept in good condition and painted regularly in order that their full value may be realized.

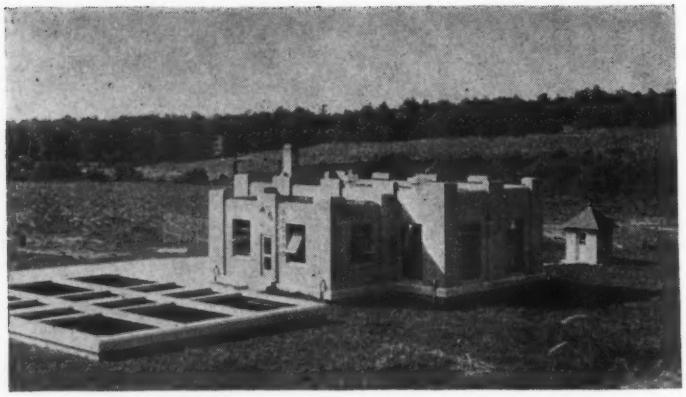
Surface:

The traveling public measures the quality of a road by the ease and comfort with which it can travel over it. Unless constant attention is given the surface or traveled track of the road, it will either deteriorate, necessitating costly replacements, or it will become too rough for safe and pleasant travel. In the case of pavements, it is necessary to keep the cracks and joints sealed to prevent damage from water and frost. Settled or broken-down places must be repaired by raising—replacement or surface patching.

On unpaved roads, it is necessary to float, drag and scrape the surfaces at frequent intervals in order that they may be smooth and in satisfactory condition for travel. Addition of new surface materials is necessary periodically to replace that which is worn away by traffic, and the application of dust palliatives is essential to make the surfaces more stable and more comfortable for travel and to avoid the dust nuisance to residents.

The conditioning of gravel road surfaces by mixing clay binder, calcium chloride, tars and asphaltic oils into the existing gravel surfaces is a very important improvement in road maintenance. If properly done, a surface which is dustless, smooth and economical to maintain, is the result. Careful laboratory testing and proportioning of the mixes is necessary to assure satisfactory results.

(Continued on page 41)



General view of filter and pumping plant as seen from the dam.

Filter and Pump

By HOWARD K. BELL and GRANT S. BELL

KENTUCKY has recently built what is known as "The Medium Security Prison" on plateau farming land of about 300 acres in Oldham County. The prison is designed for a population of 3,500 and a water supply of 350,000 gallons a day has been provided. The source of supply selected is Cedar Creek, which flows through the property, and has a watershed of about 1¾ sq. miles above the site of the impounding reservoir, which it was estimated should yield 700,000 gallons daily with proper storage. A 16″ cast iron pipe passes through the dam at stream-level and is gated at both ends, water entering from the reservoir through a swiveled intake to be described later.

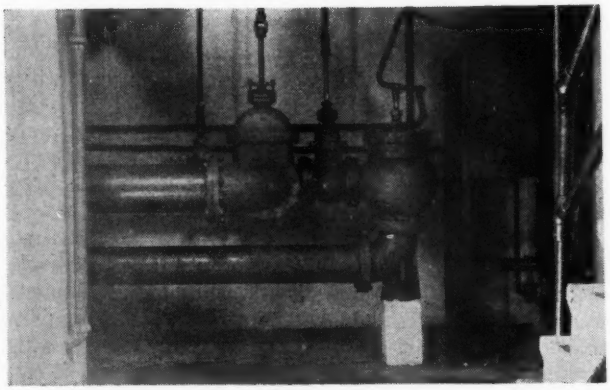
A filter and pumping plant with a capacity of 1 mgd (350,000 gallons in about 8 hrs. operating period) is located near the downstream toe of the dam, at such elevation that the upper 16 ft. of storage reaches the plant by gravity. This plant consists of three separate structures: The filter and pump building, a settling basin south of this, and a filtered water storage basin to the north.

The settling basin is a concrete rectangular structure 36 x 45 ft. and 15 ft. deep. Water enters it through a distribution line of 15″ x 6″ clay pipe tees located about two-thirds of the depth below the water surface with the tees pointing toward the wall and slightly upward. Water leaves the basin through a similar line of tees at the lower end, the tees turned downward at 45° and pointing toward the inlet end.

The clear well is of concrete 50 ft. in diameter and 10 ft. deep. It is provided with a low water float cut-off switch for the high pressure pumps and the operating mechanism of a water level gauge located on a switchboard on the operating floor. When full, it shuts down the filters through the medium of rate control float valves; it flows by gravity to, and thus primes, the high pressure pumps when within 3 ft. of full.

The Filter Plant

The filter plant comprises a mixing chamber, two filters, a combination pump and pipe gallery, and a coal storage on the lower floor; and a chemical feed room, chemical storage room and combination operating and laboratory room on the upper ground floor. Chemicals are mixed by induction into the water in a quick-mix trough, where it flows at high velocity between vertical baffles. The dosed water is piped to the bottom of a mixing chamber, the water level of which is controlled by a 10″ float valve. This mixing chamber is of special construction and will be described later. Alum and lime dry feed machines and a pre-



Filter control and float valves, with effluent chamber at left.

chlorinator are located on the floor above the mixing chamber, with short hose feed lines to the quick-mixing trough. A carbon feed machine is placed in the chemical storage room to prevent dust nuisance in the feed room. The floor of both these rooms is at the level of the bed of a truck in the roadway just outside, thus facilitating handling chemical containers.

Each of the two filters has an area of 185 sq. ft. Orifice rate control is employed and the rate can be varied from 342 to 400 gpm by raising or lowering floats on the auxiliary operated cushioned float valves on the filter discharge lines. The rate control method and strainer system will be described later.

Each filter has two concrete wash troughs with aluminum weir crests 30″ above the sand and 36″ below the top of the filter wall. The filters are equipped with surface wash consisting of a 4″ header on the longer center line with 1″ laterals spaced 18″ centers on both sides; which laterals contain ⅛″ holes spaced 9″ centers on each side, drilled horizontally and staggered so that streams from opposite laterals will not oppose one another. The interior surface of each filter wall is grooved opposite the sand layer to break up the usual tendency of wash water to flow up the wall. Filters are controlled by the usual five-valve system, the valves being of standard gate patterns with rising stems and operating stands on the floor above, the stem heights above the hand wheels showing the position of the gate valve. Though some of these are 12″ valves, they have proved remarkably easy to operate with speed by simply giving the operating wheel a whirl, so that the writer sees little added value in the much more expensive operating tables controlling valves hydraulically.

ing Plant for a Modern Institution

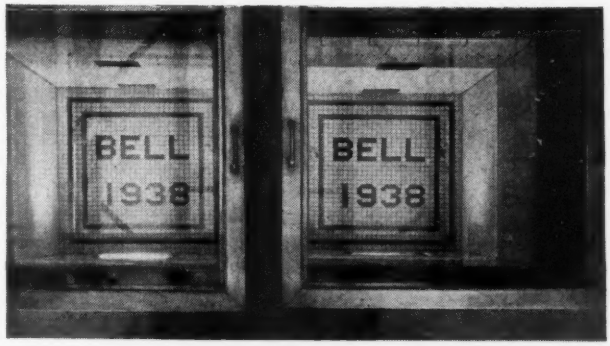
Novel features in a 1 mgd plant include swinging intake pipe, vertical flocculator, filter strainer system, and arrangement of pump room and pipe gallery.

Each filter discharges into an effluent box lined with tile and illuminated by an under-water lamp showing continuously the clarity of the water leaving each filter and giving visitors a good display of the efficiency of the plant. These effluent boxes also contain a compartment into which post-chlorination can be applied and in the bottom of which the filter rate control orifices are located.

The Pumping Plant

The pumping plant comprises three horizontal centrifugal motor-operated pumps; one a 3,500 gpm wash-water pump taking suction from the clear well; both the high-lift pumps are two stage, 1,750 rpm, one with a capacity of 700 gpm at 325 ft. head, the other of 350 gpm at 300 ft. head. The motor starters are adjacent, with push button start and stop both at the starters and at the switchboard on the operating floor; or the high-lift pumps can also be controlled automatically, starting by time switch and stopping by either time, pressure, or low-water float switch in the clear well. The pressure switch is of the retarded cushion type set for stopping at a pressure safely above the range of usual surges by means of an automatic altitude valve at the elevated reservoir which cuts off the influent when it is about to overflow, thus raising pressure in the pumping main and actuating the pump pressure stop switch. This system, with a 150,000-gallon clear well and a 150,000 gallon elevated reservoir, leaves the clear well full in the afternoon at the end of operation and fills the elevated tank during the night hours.

A combined switch and gauge panel on the operating floor gives electrical control and tells the story of plant operation by means of electric meters, pump switches, time switch, clear water level gauge, altitude and pressure gauge, wash water altitude gauge, flow meter and raw water reservoir level gauge. The chemical feed machines and flocculator motor switches are located at the machines themselves. For simplicity and ease of repair, filter loss-of-head gauges consist only of a float and tubes connected to the filter discharge pipes, with an indicator sliding on a board mounted on the operating floor.



Looking down into the effluent box, showing clarity of filtered water.

The supply line from the pumps consists of about 6,000 ft. of 10″ seven-gauge welded steel pipe protected with bituminous enamel, with Dresser type joints. The distribution system consists of 10″, 8″, 6″ and 4″ cast iron pipe, cement lined and coal tar coated. Practically all the valves are located in grass plots so, for ease of locating, the top sections of the valve boxes are made 18½″ diameter. All fire hydrants are equipped with gate valves.

The elevated storage tank is placed on the 12th floor of the tower building and is entirely enclosed and

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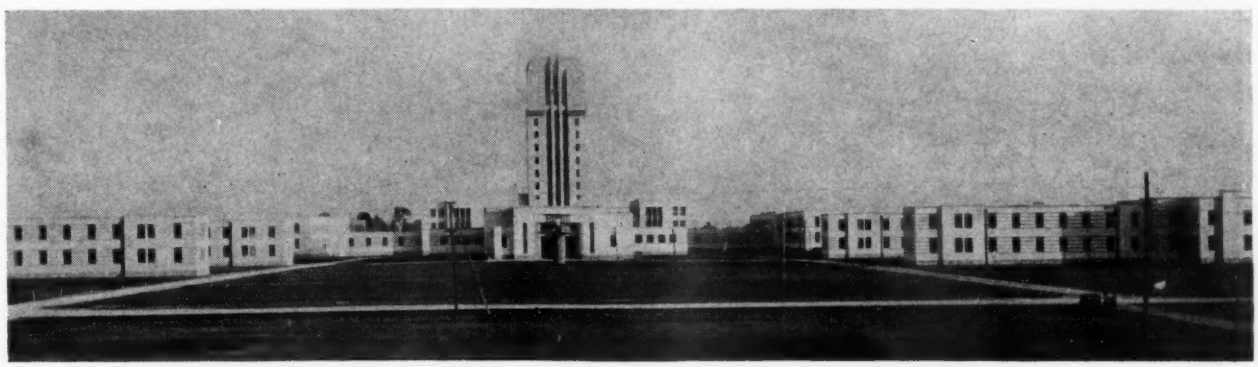


General view of "The Medium Security Prison." Central tower contains the elevated storage tank.

O. S. Covert, Jr.

Laying Mississippi's 4-Inch

By O. S. COVERT, JR.
Ass't Construction Engineer, Mississippi State Highway Department

A CONTRACT for the construction of 23½ miles of four-inch sand-asphalt pavement at an estimated cost of $9,000 per mile, was awarded by the Mississippi State Highway Department on November 28, 1939, to the Westco Construction Company.

This contract was unique in the annals of Mississippi highway construction as it was the first contract of this thickness constructed by means of mechanical spreading and finishing machines and on which side forms had been eliminated. Heretofore, the standard pavement of this general type had been a five-inch two-course pavement on which wooden side forms were used and left in place. Such a pavement generally costs about $12,000 per mile. These forms, which are 3" x 6" staked at two-foot centers, cost from six to twelve cents per square yard.

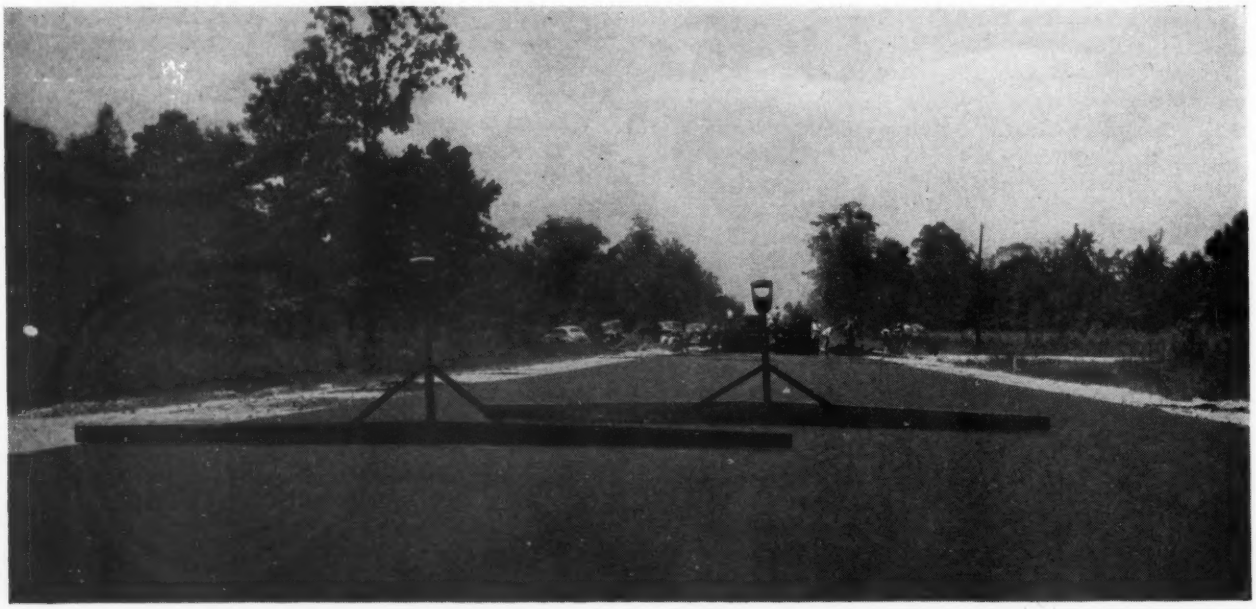
Located on Mississippi Route 13 in Marion and Jefferson Davis Counties, this project is on the shortest route from Jackson to New Orleans and is expected to carry a heavy volume of traffic. The alignment and grades are modern with only four horizontal curves in its entire length, the maximum being two degrees. Vertical sight distance is not less than 1,000 feet.

This section of Mississippi is plentifully supplied with deposits of sand clay, sand and sand gravel, so it was logical that some type of pavement should be chosen which would utilize the available aggregate. The grading of this project was completed under a previous contract and the top 15 inches of this grading contract was constructed of selected sand clay gravel with a P. I. of 4 or less. If this could not be obtained with the material available, the results were obtained by incorporating in the top 8 inches sufficient fine sand to accomplish this result.

Prior to advertising this work or deciding upon the type of pavement to be built, a study of the local sand gravel deposits was made. This study revealed one pit of a very uniform gradation, but deficient in fine sand. This pit was two miles from a railroad adjacent to the project. A suitable deposit of fine sand was located four miles from the same point. Laboratory designs were made of these deposits and a study of resultant mixes obtained by a blend of these two materials, indicated excellent results could be obtained, so the gradations required were specified for these materials. The average gradation of these deposits is as follows:

Gradation	*Sand Gravel*	*Fine Sand*
Retained ¾" sieve	3.0	0.0
Retained No. 4 sieve	15.00	0.0
Retained No. 10 sieve	20.0	5.0
Retained No. 40 sieve	46.0	20.0
Retained No. 80 sieve	91.0	75.0
Retained No. 200 sieve	97.0	90.0
Passing No. 200 sieve	3.0	10.0

A condition survey of the roads in service in Mississippi revealed that plant and road mix pavements



Two straight edges placed at right angles to center line to show uniform crown obtained.

Sand-Asphalt Pavement

Twenty-five per cent of the cost saved by reducing the thickness and eliminating the use of side forms in construction.

as thin as 2½ inches, on an adequate base, were giving satisfactory service, and it was therefore decided to effect a double barreled saving by decreasing the thickness to a total of four inches and eliminating the wooden side forms. An asphalt prime was considered necessary for the proper handling of the spreading equipment.

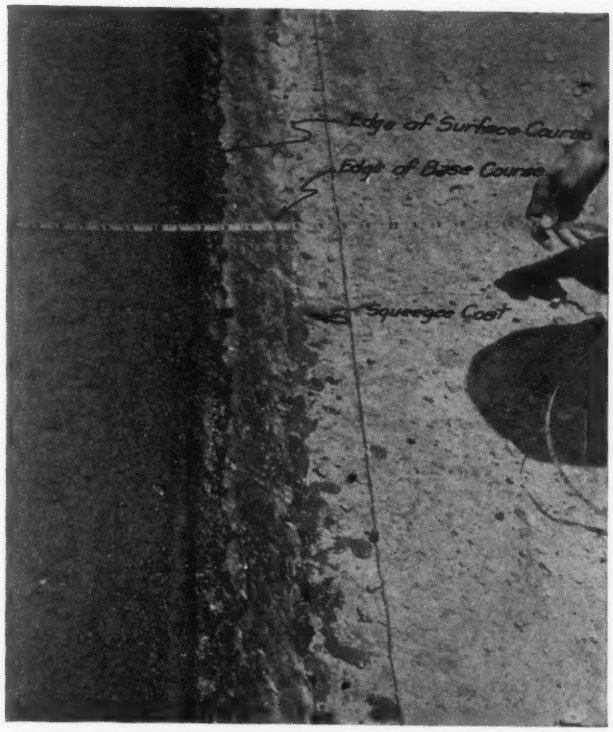
As a consequence of these investigations, therefore, the plans were drawn providing for the construction of a 2½" base course with a 1½" surface course to be placed upon a primed base. The job mix formula was determined from the blended aggregates available locally and a 60-80 penetration asphalt was proposed. A tack coat of the same penetration asphalt was provided, to be applied to the base course just ahead of the surface application.

The contractor began his base preparation in February and on May 3, 1940, after numerous delays due to excessive rains, the first paving was laid. A "Simplicity" plant was used with a minimum output of 75 tons per hour. The aggregates were blended at the plant with a clam-shell bucket, as they were fed into the cold elevator.

There are usually a number of small difficulties to be overcome when new methods or equipment are employed and this job proved no exception to this rule. The most serious encountered on this job and one that was overcome with some difficulty was a fluctuating stability in the paving mix. The specifications required two spreaders to be worked in echelon so that a "hot" center joint could be obtained. The spreaders used on these projects have a tamping screed which "floats" upon the spread material, and it was soon found that a slight decrease in the stability of the mix resulted in a lower unit bearing value at the spreading temperature of 275°-300°, which produced objectionable undulations in the riding surface. This was apparently caused by slight variations in the gradation or character of the aggregate and could not be detected in the stockpile of the mixed material prior to spreading.

Extractions made from each batch disclosed the fact that the addition of a slight amount of mineral filler would so "stiffen up" the mix that these objectionable undulations did not appear. Our design was immediately changed so that a minimum stability, determined by trial, would be obtained.

Close-up of finished pavement.



Close-up of completed pavement showing stable edge of base and surface course and the squeegee or tack coat that is broomed over the exposed edge for waterproofing.

To insure a uniformity of material that would produce these results, the coarse aggregate pit was stripped of all overburden, bored at regular intervals and a sufficient amount of fine sand spread over this deposit so that this minimum stability could be obtained at all times. Various amounts of fine sand were used, the exact quantity being determined by the gradation necessary to produce a Hubbard-Field stability of not less than 800 pounds, which has proven adequate for a number of years.

Asphalt having a penetration of 80 proved too soft, as the sand particles were round, so a 65 penetration material was selected. The same spreading temperatures were used and little or no "checking" was noted.

No further trouble was experienced with the mix after the proper stability had been obtained and the desired cross-section was easily maintained. Little or no trouble was experienced with the edges of center joints.

An analysis of the typical base and surface course mix is given herewith:

Gradation	*Percent of Total Mix* Base Course	Surface Course
Retained ¾" sieve	0.0	0.0
Retained ⅝" sieve	5.4	0.0
Retained No. 4 sieve	18.2	14.5
Retained No. 10 sieve	26.9	23.7
Retained No. 40 sieve	52.6	48.9
Retained No. 80 sieve	84.4	79.6
Retained No. 200 sieve	91.0	86.8
Passing No. 200 sieve	3.0	1.4
Mineral filler (limestone dust)	—	5.0
Percent asphalt cement	6.0	6.8
Density (percent of theoretical)	86.2	91.4
Weight per cu. ft.	127.42	134.39
Mixing temperature	280° to 310°	295° to 325°F

It is apparent that this type of construction is of sound design and will result in a saving over the standard five-inch type with side forms. The results obtained indicate it to be of lasting quality and all surface and edge requirements are satisfactorily met.

Amount of Hotel Water and Sewage

IN ESTIMATING the amount of water required by a municipality, and especially in estimating the amount of sewage to be removed, the amount of water consumed and sewage contributed by hotels is usually, we believe, guessed at rather than based upon any data, since very few figures are available. However, the amount of sewage contributed by a hotel may be a very important item in calculating the size of sewer for a given block, since a large hotel may house as many people as several blocks of residences.

Recently the American Hotel Association has collected data from over 200 hotels which should be of considerable value in planning sewers and has published the same, primarily for the purpose of aiding hotels to cut down operating expenses by reducing their water consumption.

At first thought it might seem that the amount of water consumed in a hotel would consist chiefly of that used by occupants in bathing, with a small amount used for drinking water and in the preparation of meals. However, modern hotels operate their own laundries, many of them their own refrigerating and air-conditioning plants, steam boilers and other equipment using more or less water. Also the hotels are generously provided with toilet facilities, in many cases one for each room, and leakage of fixtures in these therefore play a much larger part per occupant than in the case of private residences.

The data from 202 hotels (out of 726 which returned questionnaires but many of which were not filled out in such a way as to be used in the summary) are classified under 14 different heads, one including those operating low pressure boilers with no kitchen, laundry or air-conditioning, another those operating low pressure boilers and kitchen, a third the same with air-conditioning, etc.; other classifications including high pressure steam boilers with one or more of the supplementary uses; while others bought the steam used and 21 of them made their own electricity. The hotels were further classified as to the number of rooms, these varying from 43 to over 1500.

The average consumption per day per occupied room in these hotels varied from 144 gallons per day per room in hotels which bought the steam used and operated a kitchen but had no air-conditioning, to 533 gallons per day for those operating kitchen, laundry and some air-conditioning. One hotel reported a consumption of 1144 gpd per occupied room, having used over 254,000,000 gallons during the year 1939.

The amount per occupied room would give the total consumption of sewage discharged only in case all rooms were occupied, of course; which might occur during a few days or weeks each year. Averaging the year around, however, only about 60% of the rooms were occupied and consequently the average consumption per available room would be only about 60% of that given. This, however, would be of little consideration in designing a drainage system which must have capacity for the maximum hourly consumption.

Special mention is made of one hotel of 860 rooms which, when the air-conditioning equipment was first installed had a water consumption exceeding 137,000,000 gallons per year or 438 gallons per available room per day. All the air-conditioning cooling water was being discharged to the sewer without reuse and there was waste in the kitchen, boiler room and other parts of the hotel. During the past three years a cooling tower was installed so that the air-conditioning water could be used over and over again, boiler room losses were eliminated and much of the waste in the kitchen, laundry and elsewhere was curtailed, with the result that in 1939 the consumption was only 78,000,000 gallons, although the occupation of rooms and a restaurant business was the highest in the history of the hotel.

Sanitation of New Jersey "Public Places"

Laws of New Jersey define a "public place" as any establishment at which food is sold to the public, or water or toilet facilities are provided for public use. During 1939 the State Dept. of Health inspected 2077 rural public places, at 1646 of which food or drink was sold, these including 194 tourist homes, 141 groups of tourist cabins and 9 trailer camps. Insanitary conditions were found at 1241, ranking in seriousness from unprotected eating ustensils to unsafe water supplies and insanitary sewage disposal.

Toilet facilities were provided in 89% of the establishments, 77% having flush toilets; but 80% are in unsewered areas, and 14% of these have improper sewage disposal. The most serious violation, sewage overflowing upon the ground, was found at 87 places; stream pollution at 20. Privies were maintained at 580 places and in 240 of these the pits were not fly tight and 107 were overflowing.

Of the 1921 drinking water supplies, 57% were from private sources, of which 75% were driven wells, 24% dug wells, and 1% springs. Bacteriological samples were collected from 563 private supplies in the southern and central portions of the State, and bacteria of the Coli-aerogenes group were absent in 50 cc in 70% of them, present to the extent of 3 or less in 8%, and more than 3 in 22%. Thirty-one per cent of 291 private supplies studied in the central area of the State were open to contamination.

The State Dept. of Health believes that sanitary supervision of public places should be a function of local boards of health, but the majority of rural boards are not meeting these problems because of inadequate funds and insufficient personnel. The remedy recommended is larger local health units organized on the regional health commission plan in rural areas to provide such services on a full-time basis.

Water Works Control Equipment

Motor starters, float switches, pressure regulators, transfer equipment, anti-spin devices and other operating, supervisory and indicating equipment.

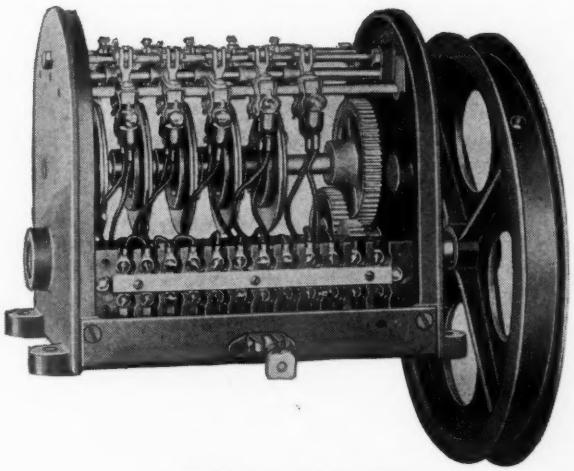
By THOMAS PALMER
Engineer, Clark Controller Co.

THE use of automatic, or at least semi-automatic, control of pumping and other equipment in water works plants is becoming more and more common, not only in the largest cities but even in the smaller communities as they come to a realization of its advantages. The chief of these are more efficient and economical operation obtained through the elimination of human errors or carelessness, and the reduction of overhead and incidental expenses through a resulting more efficient operation and the elimination of attention required with its effect on the payroll.

One of the most common uses of such equipment is the control of pumpage to elevated tanks or reservoirs, keeping these at the desired elevation. Control equipment for such installations can be divided roughly into two classifications: operating and indicating.

Under operating equipment may be listed the usual across-the-line or reduced-voltage motor starters, for the actual operation of the motors, along with the supplementary but necessary float switches, pressure regulators, transfer equipment, and anti-spin devices for the immediate control of these motor starters.

Transfer equipment is usually provided on installations where two or more pumps are necessary for the pumping requirements, or where standby pumps are installed as insurance against shutdown due to mechanical failure. Such equipment is wired so as to enable the station operator to alternate the leading pump at intervals, in order to obtain more even usage and wear on all pumps and motors; or to operate the standby pump, so that the regular equipment may be shut down for inspection or repair. Such transfer facilities may take the form of either standard double throw knife switches, radial or dial type switches, or even plugs and receptacles, but regardless of the type used, the purpose is essentially the same.



Multi-stage float switch.

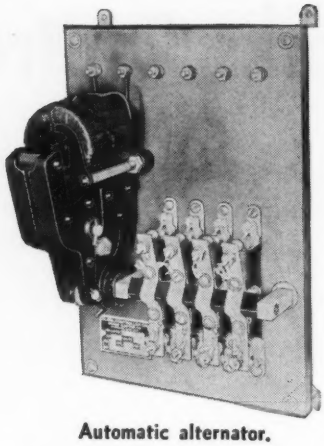
Float switch.

Volt meter.

Of special interest among transfer or alternating equipment is the "automatic alternator." This is an electro-mechanical device by means of which two pumps operating from either one or two pilot devices are automatically alternated in service after each operation. In this way each pump shares equally the work to be accomplished, and, being automatic in operation, the element of human error is eliminated. This device is obtainable in two, four, and six pole arrangements, so that any type of installation may be so equipped, regardless of whether it be supervised by two-wire or three-wire types of pilot equipment.

On a great many deep-well pump installations so called "anti-spin" equipment is now being supplied for the purpose of introducing a time interval between the shutting down and starting up of the deep-well pump. This is desirable, in view of the fact that upon shutting down a deep-well pump, the water in the discharge line of the pump between it and the usual check-valve tends to flow back into the well, thereby reversing the normal direction of rotation of the pump and motor. Any attempt to restart the motor during this period would of course result in both undesirable current inrush to the motor and mechanical stresses to the equipment and should be guarded against. The anti-spin equipment, consisting primarily of a time delay relay set for a slightly greater time interval

Bourdon tube type pressure regulator.



Automatic alternator.

than that required for the discharge line to empty, automatically introduces this delay, thereby protecting both the pump and the motor.

The maintenance of a sufficient supply of water in the storage tank may be obtained either by a pressure regulator responsive to the static head of water in the tank or by means of a float-operated device reflecting the water level, both means being in common use and both producing satisfactory results.

For float switch operation, a wide variety of types and styles of mounting are available. These contact mechanisms range from the single circuit type, intended to start and stop one pump at definite low and high water levels corresponding to predetermined settings of the device, to the multi-stage type having two or more contacts and designed primarily for starting a second and/or third pump under conditions of unusual water demand and in accordance with a predetermined pumping schedule. These may also be used for speed control of a single pump through the medium of a multi-speed squirrel cage or a wound rotor induction motor.

Of equal importance with the float switch, for water level regulation, is the pressure regulator. This auxiliary device, especially the Bourdon tube type, has been on the market and proven thoroughly dependable for many years. Since it is responsive to the static head of water in the storage tank it may be located either close to or remote from the tank, thereby making it unnecessary for control wires to be run to the top of the tank. In a great many pressure operated installations, the regulators are mounted on the switchboard at the pump house, thereby congregating at one point all of the equipment essential to the satisfactory operation of the system. This grouping of equipment at one location is especially desirable at unattended stations where only periodic servicing and supervision are provided.

In the preceding paragraphs, an attempt has been made to outline briefly the equipment listed as "operating," as compared with the following, which may be classed as "indicating" or "supervisory." Under such heading naturally come the high and low level and pressure alarms, remote level indicators, and level or pressure recorders.

Under ordinary conditions, electrical equipment carries on with a minimum of failure and servicing requirements. The trend seems to indicate, however, an increasing use of such devices as will not only provide an alarm in the event of failure but which will also provide for the station attendant a constant indication of conditions, and for the Department records, continuous charts of operation which may later be used for reference or comparison.

There are available for either level or pressure controlled systems, alarm equipment, which through relays give both audible and visible signals to the operator, advising of abnormal low or high water level. These relays, being equipped with manual release mechanisms, permit the operator to silence the gong or siren without extinguishing the visible indication, thus still warning of the abnormal conditions which may then be investigated at his convenience.

At times a continuous indication of storage tank conditions is desirable, and in such cases, meters reading in feet, gallons or other convenient quantity are often used. These are conventional voltmeters provided with special scales, and calibrated for use with a special float device. This float-operated device being equipped with a series of contacts, corresponding to the level increments to be indicated, either inserts or short circuits sectional resistors in series with the indicating instrument. This particular type of indicator, while requiring a special meter and individual calibration, once installed and adjusted is practically fool-proof, and, with a supply of fairly constant voltage, provides a reasonably accurate indication of tank conditions.

Available also to water works applications are both the continuous strip chart and the individual daily chart type of recording instruments. These are designed for operation on either level or pressure, or both, and while often used to provide a record of tank conditions, their more general uses are for recording the continuous pressure of the system, and individual or combined pumping demand.

The two classes of equipment as described above—namely, operating and indicating — supplementing each other, unite to put into the hands of the waterworks engineer a means by which definite operating schedules may be maintained, performance of equipment at remote points gauged, and the element of human error and consequent maintenance reduced to a minimum.

It may readily be seen therefore that for waterworks installations, the control manufacturers have done their part in designing and manufacturing equipment which for scope, application and variety, meets as nearly as possible all necessary requirements of this essential branch of public utilities.

The Cement Industry

According to the Federal census of manufacturing taken in 1939 there were that year 160 establishments manufacturing Portland and other cements, each having an annual production of $5,000 or more, which was an increase of two since 1937. The salaried personnel has increased from 2704 to 2768, but the number of wage earners had decreased from 26,426 to 23,801. Although the number of wage earners decreased 9.9%, the wages paid them decreased only 7.3%. The value of the cement produced increased from about $183,000,000 to $192,000,000. The barrels of Portland cement produced increased from about 116,000,000 to about 122,000,000, and the shipments in 1939 exceeded the production by about 400,000 barrels.

The Editor's Page

Preparedness Opportunities for Engineers

In carrying out its preparedness program, the Federal government finds itself in more need of more engineers than ever before. All kinds of engineers—civil, mechanical, electrical; experienced specialists, young graduates and even undergraduates of engineering schools. To the young engineers especially, opportunities are being offered both of immediate positions and of free instruction in airplane structures, camp sanitation, meteorology, topography and dozens of other branches in which their services are wanted as soon as they are competent.

Because of the urgency and importance of the need, and because we believe so many of our younger engineers want to know how they can take a part in the preparedness program, we are giving the matter prominence.

Procurement inspectors are needed at Wright Field, Dayton, O., for aircraft engines, instruments, parachutes, propellers, and tools and gauges. Experienced men are wanted for these jobs when obtainable, but the Civil Service Commission has created the position of Junior Procurement Inspector, for which college education may be substituted for experience as follows:

Graduates in aeronautical engineering will be eligible for *aircraft, engines, instruments,* and *propellers:* graduates in mechanical engineering will be eligible for *engines, instruments,* and *tools and gauges;* graduates in electrical engineering will be eligible for *instruments.*

For the upper grades, mechanical experience, which may include apprenticeship, is required in the branch applied for except that the experience on *engines, instruments,* and *tools and gauges* need not have been in aircraft work. In fact, for *engines,* mechanical experience on construction or machining of engines or as a machinist or toolmaker working to close tolerances using precision instruments or measuring devices will be acceptable. College courses in engineering may be substituted for a *part* of the experience for the upper grades.

Applicants will not be given a written test, but will be rated on their education and experience as shown in their applications, subject to verification by the Commission.

Junior inspectors receive $1,620 a year; upper grades up to $2,600. Apply for details to the Secretary, Board of U. S. Civil Service Examiners, Wright Field, Dayton, O.; to any first- or second-class post office; to the U. S. Civil Service Commission, Washington, D. C., or to any of the Commission's district offices.

Free College Training

The Federal Security Agency has arranged for intensive training, at Government expense, of 30,000 students with technical backgrounds in Enginering Schools, located geographically from Massachusetts Institute of Technology to California Institute of Technology. Courses may be whole time or part time, requiring 2 to 8 months of study, and will concentrate upon training of immediate practical application to specific defense jobs. Classes will be held both at the engineering schools and in or near industrial plants for part time or evening students.

The first courses to be established will be for inspectors of materials, chemicals, explosives, instruments and power units; designers of machinery, equipment, etc., production engineers, metallurgists, and marine engineers. Qualifications for enrollment will be determined by the institutions giving the courses in accordance with general rules suggested by the U. S. Office of Education. In most cases students will be selected from those who previously have had some technical training or its equivalent in practical experience. Students will pay no tuition charges but no provision is made to defray their living expenses.

Emergency Courses for Engineers

Since the above was written we have learned that emergency courses have been announced as soon to be offered in a cooperative program sponsored by Harvard University, Massachusetts Institute of Technology, Northeastern University, without charge for tuition. The courses will not be duplicated, but each college will teach those for which its teaching and laboratory resources are best adapted. All courses are of collegiate grade and in general the requirements for admission include at least three years in an accredited engineering school or its equivalent. Certain highly specialized courses will require engineering degrees.

The subjects of the full-time day courses, which will be the substantial equivalent to one full college term of 16 weeks, are expected to include airplane power plants, airplane structures, camp sanitation and water supply, building construction, defense production and coordination, naval architecture, marine engineering, meteorology, mapping, topography and surveying, and aerial mapping.

Application for detailed information on all courses to be given at the participating colleges in the Boston area should be made immediately and by mail only to the Engineering Defense Training Bureau, Room 7-102, Massachusetts Institute of Technology, Cambridge.

"Waterworks Digest" Completes Its Tenth Year

With this issue of PUBLIC WORKS the "Waterworks Digest" completes its tenth year. From comments received we believe that no other one feature of this publication gives as valuable service to so many classes of men interested in water works — consulting engineers and those just out of college, superintendents, managers—all who realize that they have something to learn from the printed experiences of others. In the Digest will be found brief abstracts of most of the articles presenting new worth-while ideas or facts that have been published within the previous five or six weeks (this timeliness is one of its important features), and a list of all that are not abstracted. The appreciation with which this has been received led us to perform a similar service for the sewerage field, and "The Sewerage Digest" is now in its eighth year.

Spreading tar.

Mixing.

Constructing Runways and Highways

By GEO. E. MARTIN

Consulting Engineer, General Tarvia Dept., The Barrett Co.

BUILDING roads on sandy soils is a special highway problem. Binding the sand with clay or loam is fairly satisfactory for light traffic if exactly the correct amount is used properly, but even then they are sometimes muddy or dusty; and if the clay must be hauled a long distance it may be no more expensive to use a waterproof and dustproof binder, giving satisfactory service throughout the year.

Tar has been used as a binder for sand for airport runways as well as for roads on Cape Cod and along the entire Atlantic coast from Delaware to Florida. In ordinary soil stabilization the tar acts only as a waterproofing agent and the road is bound together by the action of the clay. But in tar-sand mixes the tar must act as a binder as well as a waterproofing agent and for this reason somewhat heavy tars are used.

The following American Associations of State Highway Officials grades of tar have been used in the construction of tar-sand roads and airport runways:

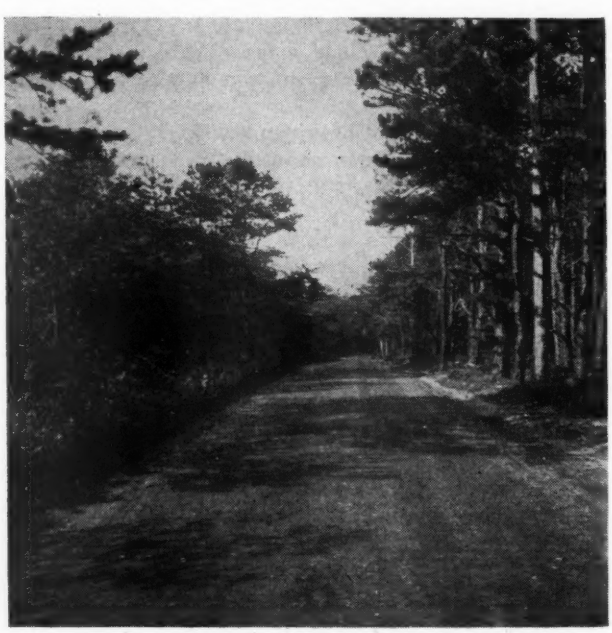
Grade	*Consistency*
RT—5	Specific Viscosity, Engler, at 50°C—17—26
RT—6	Specific Viscosity, Engler, at 50°C—26—40
RT—7	Float Test at 32°C, seconds—50—80
RT—8	Float Test at 32°C, seconds—80—120
RT—9	Float Test at 32°C, seconds—120—200

In the north RT-5 has been used commonly for the mixing course, while RT-6 and RT-7 have been used for that purpose in the south. RT-8 has been used in most cases for the seal coat.

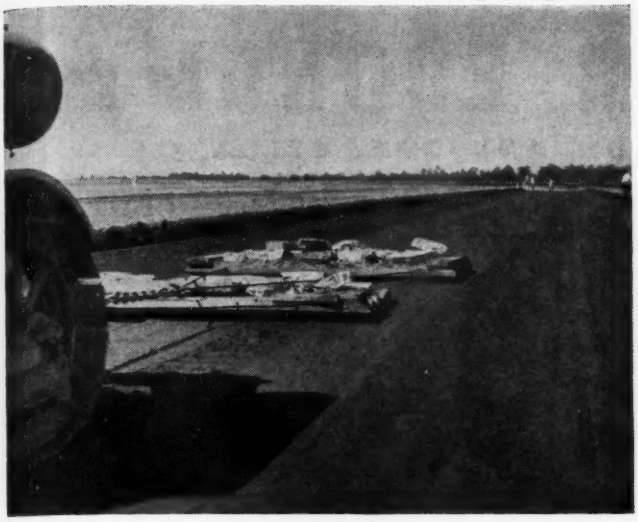
The depth of the tar-bound mix has varied with the traffic expected as well as other local conditions. Much of the work on Cape Cod is only two or three inches thick, while the runways of the Savannah airport are six inches thick.

The amount of tar in the mix varies somewhat with the grading of the sand but will usually run in the vicinity of fifteen to seventeen gallons per cubic yard of consolidated sand. A typical sand grading is that of the Savannah airport which is as follows::

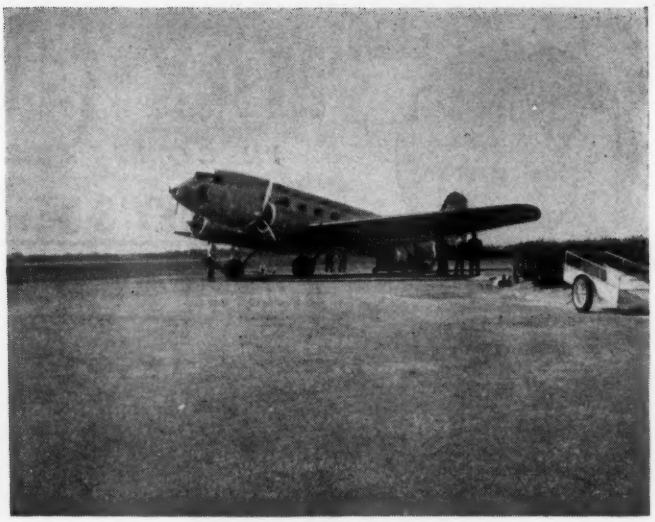
Passing No.	10 sieve, retained on No.	40 sieve	.....	2.5%
Passing No.	40 sieve, retained on No.	80 sieve	.....	36.0%
Passing No.	80 sieve, retained on No.	100 sieve	.....	29.8%



Tar-sand mix on Cape Cod.



Dragging.



Tar-bound sand at an airport.

from Shifting Sands

The grades and proportions of tar used for this purpose, methods of spreading, mixing and compacting and results obtainable.

Passing No. 100 sieve, retained on No. 200 sieve 26.2%
Passing No. 200 sieve 5.5%

For this work about three gallons of tar per square yard was used for a six-inch depth. This would correspond to eighteen gallons per cubic yard. The tar used was the RT-7 grade, which was heated to about 175° F. for application.

In building a tar-sand mix job by the road mix method the existing area to be paved is loosened to the desired depth. This is usually done by scarifiers or plows. Harrows are often used to assist in preparing the soil.

The tar is applied to the loosened surface in increments of about one-half gallon per square yard. A harrow is used immediately behind the tar distributor to cut the tar into the sand. On some jobs it has been necessary to pull the distributor with a tractor.

Projects which are more than four inches in depth must be buit in two layers. Usually in this case the required amount of tar is distributed over the top and mixed into the upper half of the pavement. This mixed material is then piled into a windrow on the side of the road or runway and the operations repeated on the lower half of the pavement.

Mixing of the tar and sand is accomplished by the use of harrows, drags and blade graders. Harrows are necessary to assist in breaking the lumps of tar and sand and to insure the uniform distribution of the tar throughout the pavement. Plank drags are often used to supplement the action of the harrows. A good blade grader is an almost essential machine on a job of this sort. The final mixing is done with the blade. The sand is rolled over and over in front of the traveling blade and is thoroughly coated with the tar binder. The blade grader is also used to spread out the tar-sand mix and to shape the surface of the pavement.

Much of the consolidation is obtained by the action of the mixing machinery. During the mixing operation the tar-coated sand is spread in comparatively thin layers and thoroughly pounded into place by the wheels or treads of the mixing machine. On some jobs a truck tire roller is used to assist in the consolidation. Final consolidation of the top is usually obtained by means of a flat-wheel roller. Both three-wheel and tandem rollers have been used. Excellent results can be obtained with either one. A blade or drag should be operated on the surface during the rolling to insure a smooth, even surface.

A job of this sort is not complete without a seal coat to act as additional waterproofing and to produce a toughened skin to resist the abrasion of traffic. Tar RT-8 is commonly used for this purpose at the rate of one-third gallon per square yard. Sand is sometimes used for the covering material over the seal coat, although better results will be obtained if a pea gravel or stone or slag-chip cover is used. About fifteen pounds per square yard of sand or twenty to twenty-five pounds of the coarser cover will be needed. The cover should be rolled in place immediately after it has been applied.

Traffic surfaces of this sort make it possible for the highway or airport official to make the best possible use of the local material available. Costs will run from twenty to fifty cents per square yard, depending upon the depth of the pavement and the amount of non-local aggregate used. Shifting sands can easily be transformed into easy-riding, all-weather roadways.

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ANNISTON, ALABAMA

Reflectorized Paint Used on Georgia Highways

Motorists who drive in Georgia by night are pleasantly surprised by the brilliance of painted center lines and "No Passing" lines on many of the pavements. It may be of interest to know that the brilliance of these lines is due to the light reflecting ability of a countless number of small beads placed on the paint while still fresh. These beads are approximately 1/8000 of an inch in diameter and resemble a fine grained sugar. Constant wear of traffic maintains the brilliance of this paint. Experience in other states shows the traffic lines of this paint will wear approximately two and one half times longer than most traffic paints making it a cheaper method of marking pavements.

Reflectorized paint or vertical rows of reflector buttons will be used by the Maintenance Division on the ends of bridges, underpass piers and abutments so that these will be clearly defined.

"Dry Water" Found

Dry water, latest in chemical curiosities, was described at the recent meeting of the American Chemical Society by Dr. Irving Langmuir, famous Nobel Prize winner.

The water is dry in only one respect—moisture does not evaporate from its surface. It appeared in layers so thin that there are only two dimensions, breadth and length, it was related by Dr. Langmuir. These films are monomolecular, consisting of a single layer of molecules.

Water and Sewage Chemistry and Chemicals

This text was prepared by **W. A. HARDENBERGH** and has been modified and improved by the following men who read it in manuscript form: **PAUL WEIR**, Superintendent of Filtration, Atlanta, Ga.—**C. R. COX**, Chief, Bureau of Water Supply, New York State Department of Health.—**A. E. GRIFFIN**, Ass't. Director, Technical Division, Wallace & Tiernan Co.—**HARRY EICHENAUER**, Operator, Liberty, N. Y., Sewage Treatment Plant.—**W. W. TOWNE**, Director, Division of Sanitary Engineering, So. Dakota State Dep't of Health.—**A. E. SIGWORTH**, Water Purification Division, Industrial Chemical Sales Division.—**LLOYD K. CLARK**, Director; Division of Engineering, No. Dakota State Dep't of Health.—**A. J. FISCHER**, Development Department, The Dorr Co., Inc.—**A. S. BEHRMAN**, Chemical Director, International Filter Co.—**T. C. SCHAETZLE**, Sup't Sewage Treatment, Akron, O.—**FLOYD G. BROWNE**, Consulting Engineer, Marion O.—**RICHARD MESSER**, Director of Sanitary Engineering, Virginia Department of Health.

CHEMICALS, in addition to their common or popular name, are represented by symbols consisting of the first or the first and another letter of their Latin (or occasionally Greek) name. For example Ca is the symbol for calcium; Fe is the symbol for iron, for which the Latin term is ferrum; Ag is used for silver, or argentum; Au is used for gold, or aurum; Pb for lead, or plumbum; N for nitrogen; H for hydrogen; and O for oxygen. There are altogether more than ninety chemical elements, of which perhaps fifteen or so are more or less commonly used in water and sewage work; however, many others are used in connection with some of the tests and analyses employed in water and sewage work.

Units of Measurement.— In water and sewage treatment and in the use of chemicals and chemical dosages, there are several methods of stating the amounts of chemicals used or the strength of solutions.

The metric system is used so universally in scientific and laboratory work that everyone should be familiar with it. The standard unit of volume is the liter (slightly more than one quart). A liter contains 1,000 cubic centimeters (usually abbreviated cc.). The term milliliter, which means one one-thousandths of a liter (and is abbreviated ml) is now more generally used than cubic centimeter, but for all practical purposes the terms are interchangeable. The standard unit of weight is a gram, which is the weight of one cc. of water at a standard temperature. The kilogram (kg.) is 1,000 grams (about 2.2 pounds); the milligram (mg.) is one one-thousandths of a gram. It is convenient to remember that 1 mg. per liter equals one part per million (abbreviated ppm.).

Chemicals are measured, in terms of dosages, in three common ways: Grains per gallon (gpg.); parts per million (ppm.); and pounds per million gallons. Grains and grams are not equal and must not be confused; 1 gram equals 15.432 grains.

There are 7,000 grains in the ordinary avoirdupois pound of 16 ounces. Therefore 1 grain per gallon equals 1 pound in 7,000 gallons, or 142.9 pounds per million gallons (1,000,000 ÷ 7,000 equals 142.9). A gallon of water weighs 8.34 pounds. Therefore 1 gpg. equals 142.9 ÷ 8.34, or 17.1 parts per million. To summarize:

1 gpg. = 17.1 ppm. = 142.9 lbs. per mg.

1 ppm. = 0.058 gpg. = 8.34 lbs. per mg.

1 lb. per mg. = 0.007 gpg. = 0.12 ppm.

1 mg. per liter = 1 ppm. = 8.34 lbs. per mg. = 0.058 gpg.

Canadian or Impartial gallons are somewhat larger than United States gallons—the U. S. gallon equals 0.83 Imperial or Canadian gallon—and the above figures should be modified accordingly.

The Baume scale is used in the chemical industry. The following data are abstracted from General Chemical Co. Products Book:

In nearly all instances the specific gravity or density in water of solutions of pure chemicals, such as acids, alkalies and salts, varies in proportion to the amount of these constituents present. This fact is used to determine the strength of solutions by obtaining their densities. The method is rapid, sufficiently accurate for most purposes and avoids the necessity for making a chemical analysis.

The terms density and specific gravity, while strictly not synonymous, are generally interchangeable in representing the weight of a volume of liquid compared with the weight of an equal volume of water. Since the densities of liquids vary with the temperature, the temperature must always be specified. Chemical manufacturers in the United States have agreed on and use 60°F as a basis for specific gravity and most tables are prepared on this basis.

While specific gravity must be expressed by figures such as 1.0762, it is the custom in the chemical industry to employ the Baume scale, which permits the number of decimal figures to be reduced. The relation of the Baume scale to specific gravity is as follows:

$$\text{Degrees Baume} = 145 - \frac{145}{\text{Sp. Gr.}}$$

for liquids heavier than water.

$$\text{Degrees Baume} = \frac{140}{\text{Sp. Gr.}} - 130$$

for liquids lighter than water.

The determination of the specific gravity of a solution as a means of obtaining its strength is done conveniently by means of a Baume hydrometer. When such determinations are carried out properly, results can be obtained which are accurate within 0.20° Baume, which in the case of sulfuric acid is equivalent to Sp. Gr. 0.0004 at 66° Baume, or to within 0.11%. This degree of accuracy compares favorably with that obtained by chemical analyses and is satisfactory for most purposes. To obtain this degree of accuracy, high grade and reliable hydrometers must be used. These should have an overall length of about 12 ins. and half of this length should be graduated in the Baume scale at 60°F; the scale should be limited to 10° Baume or less and should be divided into degrees and tenths. To cover a range of liquids, several hydrometers will be needed.

Here is an example.—The specific gravity of sulfuric acid (H_2SO_4) of a certain strength is 1.835. Using this specific gravity and the Baume

formula:

$$\text{Baume} = 145 - \frac{145}{\text{Sp. Gr.}} = 145 - \frac{145}{1.835} = 145 - 79.02 = 65.98$$

The standard grade of sulfuric acid is the 66° Baume, which is 93.19% H_2SO_4; 60° Baume has 77.67% H_2SO_4.

Chemical Terms and Symbols

There are two branches in chemistry, organic and inorganic. Organic chemistry deals with the many combinations of carbon, principally with hydrogen and with hydrogen and oxygen, such as asphalt, gasoline, methane, acetic acid, fatty acids, glycerine, coal tar, gasoline and thousands of others. Since living organisms and their products belong in the hydrogen-carbon group, these are dealt with in organic chemistry. Inorganic chemistry covers all combinations except those included in organic chemistry.

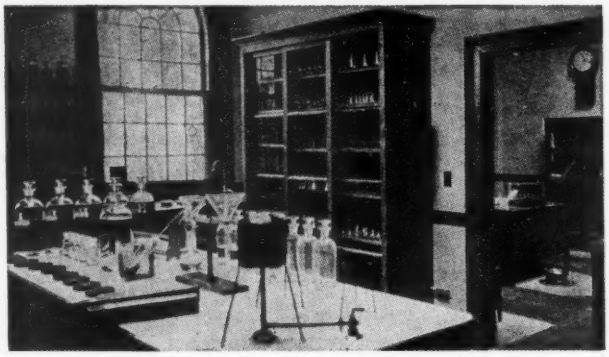
Elements.—In chemistry, elements are those substances that cannot be divided into simpler substances. Each element consists wholly and only of atoms of one and the same kind. All of the various forms of matter that we know of are composed either of these single elements or of combinations of them, but by far the great majority of them are compounds of two or more elements. Actually most compounds are relatively simple, and few of them contain more than four or five elements.

Atomic Weights. — Each known chemical element has an atomic weight. These atomic weights are relative only. They are based on an assumed atomic weight of 16.000 for oxygen and actually represent ratios between the true weight of oxygen and the true weight of the other elements. This weight having been assumed, it is then possible to compute the weights of the other elements.

Among those chemicals that are used frequently or occasionally in water or sewage work are:

Chemical	*Symbol*	*Atomic Weight*	*Chemical*	*Symbol*	*Atomic Weight*
Aluminum	Al	26.97	Mercury	Hg	200.61
Barium	Ba	137.36	Nitrogen	N	14.01
Calcium	Ca	40.08	Oxygen	O	16.00
Carbon	C	12.01	Platinum	Pt.	195.23
Chlorine	Cl	35.46	Potassium	K	39.10
Copper	Cu	63.57	Silicon	Si	28.06
Hydrogen	H	1.01	Silver	Ag	107.88
Iodine	I	126.93	Sodium	Na	23.00
Iron	Fe	55.84	Sulfur	S	32.06
Magnesium	Mg	24.32	Phosphorus	P	31.02
Manganese	Mn	54.93	Lead	Pb	207.21

The figures given above are the International atomic weights for 1937, correct to the nearest two decimal places.



Interior of a well equipped laboratory.

Specific Gravity. — Liquids, solids and gases have specific gravity. The specific gravity of water is 1.00. In the case of a liquid or solid that has, for instance, a specific gravity of 1.85, it is 1.85 times as heavy as water. Gases are compared to pure, dry air as the unit. A gas having a specific gravity of 1.85 weighs per unit of volume (as 1 cubic foot) 1.85 times as much as an equal volume of air at the same pressure and temperature.

Proportions and Combinations.— Any compound of any of the elements will always be in proportion to these atomic weights. That is, a compound of one atom of iron and one atom of sulfur, always will be in the proportion of 55.84 parts of iron to 32.06 parts of sulfur; and by percentage, the composition would be 62.4% of iron and 37.6% of sulfur. In all combinations of chemicals, the relative weights are in accordance with the atomic weights.

The compound of iron and sulfur mentioned above is iron sulfide; under proper conditions 55.84 parts of iron and 32.06 parts of sulfur will combine, forming 87.90 parts of the sulfide. If there is an excess of either iron or sulfur, the excess will be unchanged and will not combine. Likewise, in forming common salt, NaCl, there will be 23.00 parts (grams, pounds or tons) of sodium (Na) to 35.46 parts (grams, pounds or tons) of chlorine (Cl). If there are 30 pounds of sodium to 35.46 pounds of chlorine, 7 pounds of the sodium (30-23) will not combine with the chlorine, but will remain intact as sodium.

Thus in any chemical compound, the proportions by weight of its elements are always the same.

There are some chemical elements, however, that combine in more than one proportion to form more than one compound. Carbon and oxygen may unite in the proportion of 12.01 to 16.00 to form carbon monoxide (CO), a gas that is known for its poisonous effect when inhaled; but carbon and oxygen also may unite to form carbon dioxide (CO_2) in which case the proportions are 12.01 parts of carbon to 32.00 parts of oxygen.

These rules apply to all other compounds also. In each case a simple ratio exists between the weight of the elements, and the composition of the compound will be constant and will always be formed when the conditions are the same. Also, when a fixed weight of one element unites with several weights of another element to form compounds, these several weights are always in a simple ratio to each other—that is they will be 2, 3, 4 or 5 times as great as the least weight that will combine.

Solutions and Suspensions.—When a solid is dissolved in a liquid it forms a solution; gases or other

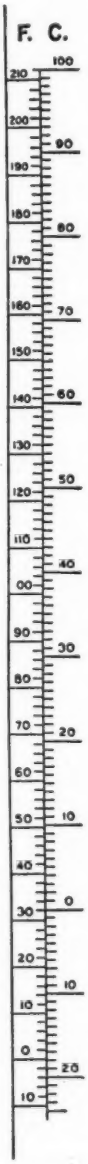


Fig. 1. At the left is a scale by which Fahrenheit and equivalent Centigrade temperatures may be read directly (ee first two paragraphs at left).

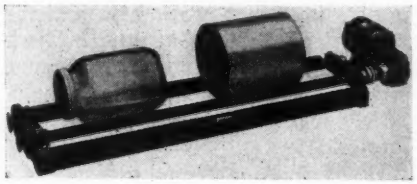
Fig. 2. Below is an Imhoff Cone, essential in making tests for settleable solids.

liquids may also be disolved in a liquid in a like fashion to form a solution; and even some solids may be dissolved in other solids. Examples of a solid dissolved in a liquid are aluminum sulfate or sodium carbonate dissolved in water; while a water solution of chlorine is an example of a gas dissolved in a liquid.

There are some substances that do not dissolve, as activated carbon. Where the particles of a solid are spread or dispersed through the liquid in a very finely divided state, the mixture is called a suspension. A mixture of Fullers earth and water, such as is used in making turbidity standards, is also a suspension.

Solutions may be called dilute when they are weak, that is, when they contain only a small amount of dissolved material; or concentrated if very strong; or saturated, at which point the liquid is unable to take up any more of the solid or gas.

For proper use, the strength of solutions should be known, and in laboratory work solutions of a definite, known strength are used in order to



Omega jar mill laboratory mixer.

make chemical calculations easier. The preparation of such solutions having a definite strength will be discussed later.

Mixtures and Compounds.—A mixture of two atoms of hydrogen and one atom of oxygen does not produce water, which has the chemical formula of H_2O; but if the mixture of these two gases is ignited, as by an electric spark, the two gases combine explosively to form water. Hydrogen gas and chlorine gas when mixed together and exposed to sunlight form a compound, HC1, or hydrochloric acid. Copper filings and powdered sulfur mixed together are only a mixture, but when the mixture is heated, it changes its character and becomes copper sulfide.

While outside agencies, as heat or light, are sometimes needed to cause these chemical reactions, this is not always the case. Often the mere mixing of the substance will result in the formation of the compound.

From the above it will be noted that a compound is a chemical combination of two or more substances, while a mixture is only a mechanical combination; the former cannot be readily resolved into its original parts, while the mixture can.

Valence.—Chemicals have a certain combining power, which is called valence. Using the valence of H as 1, the valence of the other elements is determined. Thus, since H and C1 unite to form HC1, the valence of C1 is also 1; two atoms of H unite with one of O to form H_2O and therefore the valence of O is 2. Some elements have different valences under different conditions. For instance, CO (carbon monoxide) indicates that C has a valence of 2; but in CO_2 (carbon dioxide), C has a valence of 4.

In general, valence is not highly important to the man engaged in water and sewage work and who is interested only in the terms and usages commonly employed in such work.

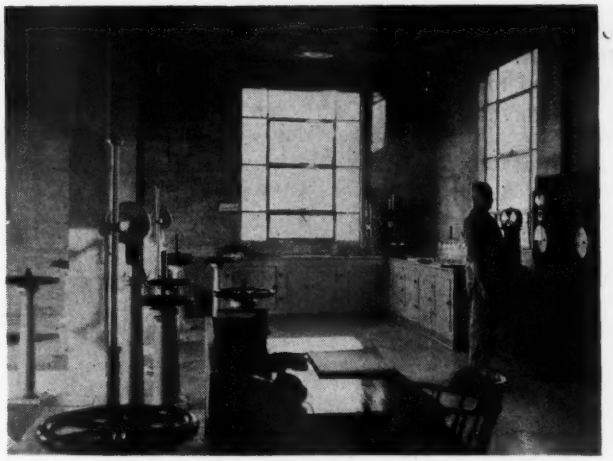
Acids.—An acid is a compound that contains hydrogen which may be replaced by the metal of a base to form a salt. Thus HC1 (hydrochloric acid) may be changed to NaCl (common salt) by replacing the H with Na. H_2SO_4 (sulfuric acid) is changed to $CaSO_4$ (calcium sulfate or gypsum) by replacing the H with Ca.

Bases.—The oxides and hydroxides of the metals are called bases. They react with acids to form salts, as stated above. In this connection, the term "metal" is not restricted to copper, lead, iron, tin, silver, gold, etc., but includes also potassium, sodium, calcium, magnesium, etc.

An example of a base is CaO (calcium oxide or lime) which combines with H_2SO_4 to form H_2O and $CaSO_4$; or with carbonic acid, H_2CO_3 to form H_2O and $CaCO_3$ (calcium carbonate).

Ionization.—When acids, bases and salts are dissolved in water their molecules are broken up into positive and negative elements or groups of elements each carrying an electrical charge. These are called positive and negative radicles (or radicals). These charged radicles are called ions. For instance, hydrogen chloride dissolved in water dissociates and the degree to which this dissociation takes place is dependent upon the concentration of the chemical in the water and on the temperature during dissociation. In a normal solution (see this text later for definition of a normal solution) of hydrochloric acid at 18°C, equilibrium is attained with 78% of the HC1 dissociated. This can be expressed as:

$$\underset{22\%}{HC1} \rightleftharpoons \underset{78\%}{H^+\ C1^-}$$



Filter operating room and laboratory.

This means that in a normal solution of HC1 at a temperature of 18°C there is always 22% of the HC1 in its original combined form and 78% in the form of positive and negative ions. This condition is not static, as the H^+ and the Cl^- are constantly combining to form HC1 with no electrical charge, and part of the HC1 is constantly splitting up into more H^+ and $C1^-$ ions. But the balance is always maintained unless the temperature or the concentration change. Increasing the temperature increases the dissociation and vice versa; increasing the concentration decreases the dissociation. Ionization always tends to become more complete as the dilution becomes greater.

Because *only* the ions in a solution enter into a chemical reaction an acid or a base is known as strong or weak, depending on how much it is ionized in solution,, as are the strong bases such as sodium hydroxide and potassium hydroxide. Acetic and carbonic acids are but slightly ionized and are therefore known as weak acids. Ammonium hydroxide is a very weak base because of its low "dissociation constant," that is, because of its small degree of ionization.

When two or more acids and bases or salts are dissolved in the same solution, new compounds are formed. If the new compounds are all soluble in water, they intermingle, combine and dissociate and cannot again be separated easily. If, however, one of the compounds is a gas, CO_2 for instance, or is a substance insoluble in water (as aluminum hydroxide, commonly called alum floc) it will become chemically inactive and will leave the reaction. For example, when aluminum sulfate or alum ($A1_2(SO_4)_3$) is dissolved in water it dissociates into $A1^{+++}$ and SO_4^{--}. If lime is present in the water as $Ca(OH)_2$, it too will dissociate into Ca^{++} and OH^-. These four ions and two salts are in one solution and are

moving around freely, coming into contact with each other. Positive ions are attracted to the negative ions and they combine. When the Ca^{++} and the SO_4^{--} ions combine, they form $CaSO_4$ which, being soluble in water, dissociates again and continues in solution. However, when the Al^{+++} ion combines with the OH^- ion, aluminum hydroxide is formed which, being insoluble in water does not again dissociate. Thus a floc is started which grows as more molecules of aluminum hydroxide form, until it is the visible floc seen in the coagulation basin. Thus two ions have combined to form a substance which no longer dissociates and which leaves the solution. Gases, when formed in quantities greater than can be held in solution, likewise leave, except that they obviously escape from the suface rather than settle. As ions of aluminum (Al^{+++}) leave the solution in the form of the insoluble floc, the normal balance $Al_2(SO_4)_3 \rightleftharpoons 2Al^{+++} + 3SO_4^{--}$ is disturbed and more $Al_2(SO_4)_3$ dissociates and is removed by combining with the hydroxylion OH^- until all of the alum is used up.

How Chemicals Combine

Atomic and molecular weights are used to show the proportions by weight of each of the elements entering into a compound; and they may also be used for checking an equation, since the weight on both sides of an equation must balance, for instance:

sulfuric acid + quicklime = calcium sulfate + water

$$\underset{98.08}{H_2SO_4} + \underset{56.08}{CaO} = \underset{136.14}{CaSO_4} + \underset{18.02}{H_2O}$$

The atomic weights of the compounds shown in the bottom line of the above equation totalling 154.16 on both sides of the equation indicates that it is correct. Similarly:

sulfuric acid + sodium hydroxide = sodium sulfate + water

$$\underset{98.08}{H_2SO_4} + \underset{80.02}{2NaOH} = \underset{142.06}{Na_2SO_4} + \underset{36.04}{2H_2O}$$

The weight ratio method shown is important in solving various problems in chemical feeding. For instance, how much sulfuric acid would be required to combine with 100 pounds of CaO, and how much gypsum (calcium sulfate) would be formed?

From the reaction above 98.08 pounds of sulfuric acid are required for combining with 56.08 pounds of CaO. Therefore, 100 pounds of CaO will require 100 x 98.08 ÷ 56.08 = 175 pounds of sulfuric acid; and this will produce 100 x 136.14 ÷ 56.08 = 243 pounds of $CaSO_4$; the remainder will be water, as shown in the equation above, amounting to 100 x 18.02 ÷ 56.08, or 32 lbs.

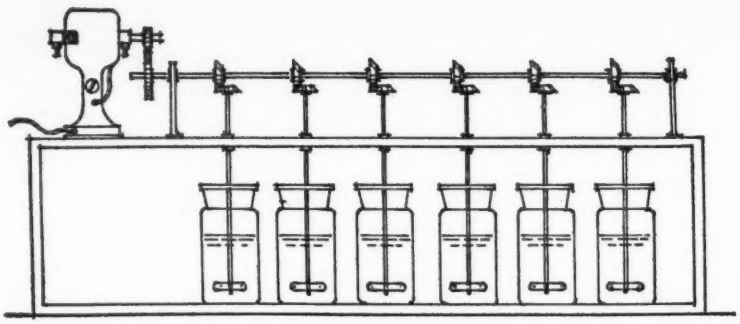


Fig. 22. A handy stirrer for laboratory use. (Courtesy National Lime Ass'n).

Water Content.—Some formulas are written thus: $FeSO_4.7H_2O$. The $FeSO_4$ indicates ferrous sulfate; the H_2O indicates that the compound is a hydrate, that is, that it contains water; and the 7 indicates the amount of water it contains. Thus the true crystal of aluminum sulfate has the formula $Al_2(SO_4)3.18H_2O$, but aluminum sulfate is obtainable with either less or more water content. The water content is important in purchasing by weight, and also in computing dosages by weight of crystal. It is important to buy chemicals on the basis of their chemical content. Aluminum sulfate should be purchased on its content of Al_2O_3, and ferric chloride and ferrous sulfate on their iron content.

Terminology.—As already stated, the force that holds the elements together into compounds is electrical in nature; and since these elements having like electrical charges will not combine, compounds are made up of electro-positive and electro-negative elements. Hydrogen and the metals are positive; and chlorine, oxygen, etc., are negative. When joined in a compound, the name is formed by the name of the electro-positive element, followed by the name of the electro-negative, with the suffix or ending "ide," as sodium chloride (NaCl), calcium oxide (CaO), zinc sulfide (ZnS) and aluminum oxide (Al_2O_3). When two elements form more than one compound, a numerical prefix is used on the electro-negative term, as carbon monoxide (CO), carbon dioxide (CO_2), phosphorous trioxide (P_2O_3) and phosphorous pentoxide (P_2O_5).

Where elements form more than one oxide, the suffix "ous" is used to indicate the lower condition of oxidation, and the suffix "ic" to indicate the higher condition. For example, cuprous oxide (Cu_2O) and cupric oxide (CuO). The same suffixes are used in the same way with acids. Sulfurous acid (H_2SO_3) is a combination of sulfur dioxide and water; sulfuric acid (H_2SO_4) is a combination of sulfur trioxide (SO_3) and water.

The terminations "ite" and "ate" are used to indicate the salts derived from acids terminating in "ous" and "ic," as sodium sulfite (Na_2SO_3) which is derived from a combination of sodium hydroxide (NaOH) with sulfurous acid, and sodium sulfate (Na_2SO_4), which is formed by sulfuric acid and sodium hydroxide.

In some cases there are compounds still lower or higher in the series than those employing "ous" or "ic" endings. The prefix "hypo" is used to distinguish those that are lowest, and the prefix "per" those that are highest. For example, hypochlorous, chlorous, chloric and perchloric acids; and hypochlorites, chlorites, chlorates and perchlorates.

The Nitrogen Cycle.—When organic matter decomposes as occurs in sewage, the proteins, starches, sugars and other compounds are broken up; methane (CH_4), carbon dioxide (CO_2), hydrogen sulfide (H_2S), nitrogen (N) and other gases are given off. The nitrogen first appears as free ammonia (NH_3), combining with hydrogen.

Treatment of sewage to prevent nuisance involves oxidation or the adding of oxygen. This is accomplished by trickling filters, by aeration or by other means. The oxygen combines with the nitrogen to form nitrates (NO_2), which mark the first step in oxidation or stabilization. In water supply, the presence of nitrates indicates comparatively recent contamination with organic matter, since time has not been available for the nitrites to combine with still more oxygen to form nitrates (NO_3). In sewage treatment, as added oxygen is made available, the nitrates are converted to nitrates. If this oxygen is not supplied by treatment processes, nature must supply it at the expense of the water into which the sewage is discharged.

The nitrogen cycle is completed when the nitrates are converted to plant foods, which are eaten by animals; the animals die and their tissues decompose, producing nitrogen.

Some Chemicals Used in Water and Sewage

Gases.—Chlorine: Symbol Cl; specific gravity 2.49; atomic weight 35.46. Chlorine is a greenish-yellow gas which, under pressure, is converted to a liquid. Either as a gas or as a solution, it is used for killing bacteria, for checking the growth of or killing algae or slimes and for other purposes in water treatment. It is irritant to the lungs and membranes of the nose, throat and respiratory system, and causes violent coughing. A concentration of 1 part of chlorine in 100,000 of air can be noticed; 1 part in 50,000 parts of air causes inconvenience; and 1 part in 1,000 of air may produce death after 5 minutes exposure. It is heavier than air and therefore will be most dense near the floor. It combines with ammonia to form ammonium chloride, a white, cloudy gas. The test, therefore, for chlorine leaks is to hold a bottle of ammonia at valves, connections and other places where chlorine may be leaking. Gas masks are available to protect against chlorine, but masks designed for protection against other gases may not be effective against chlorine.

Oxygen.—Symbol O; specific gravity 1.105; atomic weight 16.00. Oxygen is a colorless, odorless gas which combines readily with many elements to form numberless compounds, both organic and inorganic.

Hydrogen. — Symbol H; specific gravity 0.07; atomic weight 1.01. Hydrogen is the lightest known material; it is a constituent in all acids, and combines with many other elements. In combination with carbon, it forms coal.

Nitrogen. — Symbol N; specific gravity 0.97; atomic weight 14.01. Nitrogen is an odorless, colorless and tasteless gas.

Acids. — Hydrochloric (Muriatic) Acid: By mixing equal volumes of H and Cl and exposing the mixture to a flame or bright light, HCl is formed. The resulting gas is dissolved by water to form hydrochloric acid. The term hydrochloric acid is frequently applied to either the gas or the solution in water, although the correct term for the gas is hydrogen chloride. HCl in solution form is clear or slightly yellow, with a pungent odor and a corrosive action. The standard grade has a specific gravity of 1.178 to 1.188 and a strength of 35% to 37%.

Nitric Acid, sometimes called aqua fortis, has the formula HNO_3. It is a clear, colorless or yellow liquid, with a pungent odor and is extremely corrosive. It is subject to decomposition by sunlight, turning brown on exposure. Nitric acid 36° Baume contains approximately 52.3% HNO_3, but stronger concentrations are available.

Sulfuric acid, H_2SO_4, is a clear or slightly cloudy, heavy liquid with an extremely corrosive action. Specific gravity is from 1.835 to 1.840. Probably the most generally used grade is 66° Baume, which has a strength of 93.2%, but other concentrations are available. The CP (meaning chemically pure) grades are usually 95% to 96% H_2SO_4, the remainder being water, which sulfuric acid takes up readily from the atmosphere. For this reason, solutions may lose strength on standing and must be tested from time to time to determine the concentration. If water is added to concentrated sulfuric acid, violent heat is generated and there may be an explosion; therefore, the acid should always be added to the water and in small quantities and carefully.

Carbonic acid, H_2CO_3, is formed by dissolving CO_2 (carbon dioxide) in water, the reaction being:

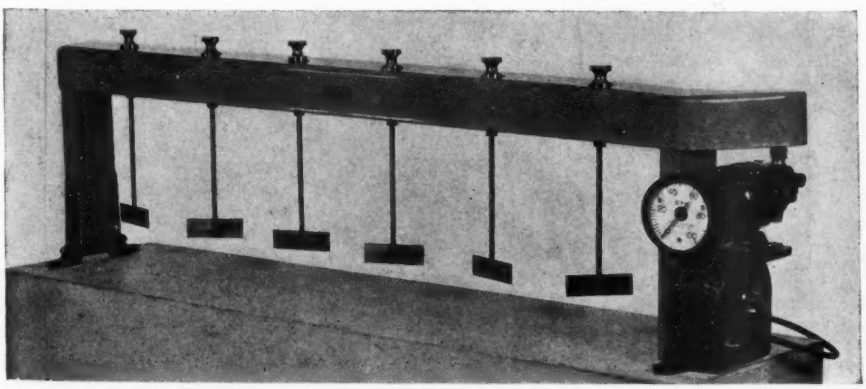
water+carbon dioxide=carbonic acid

$$H_2O + CO_2 = H_2CO_3$$

H_2CO_3 is a weak acid; in fact it is used in most charged waters and soft drinks. It combines readily with sodium, calcium and magnesium to form carbonates, as follows (for calcium):

carbonic acid+lime=
calcium carbonate+water

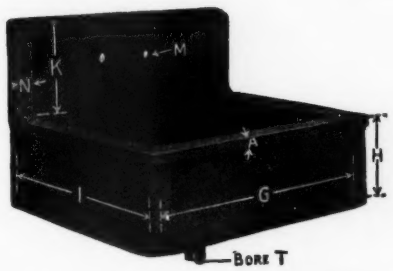
$$H_2CO_3+CaO=CaCO_3+H_2O$$



Phipps & Bird laboratory stirrer.

With sodium, it forms sodium carbonate or soda ash; and with magnesium, $MgCO_3$, or magnesium carbonate.

Calcium and Magnesium Compounds.—Calcium, symbol Ca, atomic weight 40.08, is an alkaline-earth metal or alkali. A common compound of calcium is CaO, or quicklime, which



Stoneware sink, Maurice A. Knight.

has an affinity for water which it may take up from the air; or water may be added to slake the lime. In either case, the result is hydrated lime Ca(OH). The reaction is:

lime+water=hydrated lime

$$CaO+H_2O=Ca(OH)_2$$

When carbon dioxide comes in contact with lime, it forms calcium carbonate:

carbon dioxide+hydrated lime=
calcium carbonate+water

$$CO_2+Ca(OH)_2=CaCO_3+H_2O$$

If still more H_2CO_3 is added, bicarbonate is formed, as follows:

calcium carbonate+carbonic acid=
calcium bicarbonate

$$CaCO_3+H_2CO_3=Ca(HCO_3)_2$$

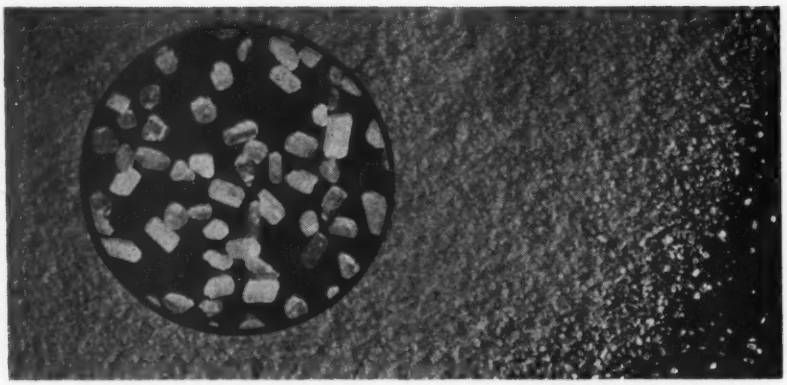
Calcium unites with chlorine to form calcium chloride ($CaCl_2$), a chemical used for road construction, for dust-laying, for melting ice and for many other purposes. Calcium sulfate, $CaSO_4$, commonly called gypsum, is an important building material and is the base for plaster of paris. Calcium hypochlorite will be considered later.

Magnesium, symbol Mg, atomic weight, 24.32, is often found in association with calcium. It enters generally into the same compounds as calcium. With calcium it is responsible for the carbonate hardness in water. The so-called temporary hardness of water is due to calcium and magnesium bicarbonates, $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$. When water containing these compounds is heated, the carbon-dioxide is driven off leaving carbonates, which are quite insoluble and can be removed by settling.

Calcium bicarbonate—carbonic acid
=calcium carbonate

$$Ca(HCO_3)_2—H_2CO_3=CaCO_3$$

Carbonate hardness, which is not re-



Courtesy General Chemical Co.

Trisodium phosphate actual size and in inset magnified five times.

movable below about 1 or 2 grains per gallon (17 to 34 ppm.) is caused by $CaCO_3$ and $MgCO_3$. Non-carbonate hardness is caused by $CaSO_4$ (calcium sulfate), $MgSO_4$ (magnesium sulfate), $CaCl_2$ (calcium chloride) and $MgCl_2$ (magnesium chloride). Other compounds in water which cause alkalinity and salinity are mainly those of sodium and potassium, which will be discussed later.

In calcium oxide (CaO), since calcium has an atomic weight of 40.08 and oxygen an atomic weight of 16.00, the total or molecular weight is 56.08. Hydrated lime consists of CaO and H_2O, and is therefore $Ca(OH)_2$; the molecular weight is 40.08+2.02+32.00, or 74.10. On the basis of effective CaO, therefore, hydrated lime is equal to 56.08+74.10=75.7% of CaO.

Sodium and Potassium. — Sodium, symbol Na, atomic weight 23.00, is an alkali metal. Perhaps its principal use in water purification is as sodium carbonate, Na_2CO_3, which is used in the same way lime is used to provide alkalinity or correct corrosiveness or an acid condition in water. Other forms are sodium sulfate (Na_2SO_4), sodium chloride or common salt (NaCl); sodium hydroxide or caustic soda (NaOH); sodium thiosulfate $Na_2S_2O_3.5H_2O$) used to romove an excess of chlorine following superchlorination; sodium silicate or water glass (Na_2O, X (SiO_2) plus water, which is used for coating the inside of water pipes to prevent corrosion; sodium metasilicate ($Na_2SiO_3.5H_2O$) which is sometimes used to prevent scale formation or corrosion, and sodium hexa-metaphosphate, recently advanced as an inhibitor of calcium and other carbonate deposits. Potassium, symbol K, atomic weight 39.10, is an alkali metal resembling sodium in many of its characteristics.

Aluminum.—The formula for aluminum sulfate is $Al_2(SO_4)_3$. Theoretically the crystal formula is $Al_2(SO_4)_3.18H_2O$, but as produced commercially the formula is $Al_2(SO_4)_3.14H_2O$. As already stated, the H_2O indicates that the compound is a hydrate (contains water) and the 14 or 18 indicates the amount of water it contains. Aluminum sulfate, which is commonly called "filter alum," is used for coagulation in both water and sewage treatment. The floc that is formed and which assists settlement by attracting and carrying down much of the suspended and some of the colloidal matter is aluminum hydroxide. The reaction is coagulation, when lime is used to supply the alkalinity necessary for reaction is:

aluminum sulfate+hydrated lime=
calcium sulfate+aluminum hydroxide

$$Al_2(SO_4)_3+3Ca(OH)_2=3CaSO_4+2Al_2(OH)_3$$

A fuller discussion of the use of aluminum sulfate in water coagulation is given in "The Operation of Water Treatment Plants," published in this magazine in April, 1938; and in sewage coagulation in "The Operation of Sewage Treatment Plants," published in this magazine, September, 1938.

Ammonia alum is sometimes used for coagulation, but since the cost is much more than that of aluminum sulfate, it is economical only for certain conditions, as with pressure filters and alum pots. The formula for ammonia alum which is a true alum is $Al_2(SO_4)_3.(NH_4)_2SO_4.24H_2O$. Ammonia alum dissolves more slowly which is an advantage for pressure filter installations. Based on the Al_2O_3 content, the cost is about three times as great as for ordinary or filter alum.

Sodium aluminate ($Na_2Al_2O_4$) is another coagulant that is advantageous for certain uses, primarily with water used for boilers or for steaming purposes. It, also, is more costly than aluminum sulfate.

The Iron Compounds.—Iron, symbol Fe, atomic weight 55.84, is used in water and sewage coagulation in a number of forms, including the following:

$FeSO_4$ ..... ferrous sulfate
$Fe_2(SO_4)_3$ ..... ferric sulfate
$FeCl_3$ ..... ferric chloride

Ferrous sulfate, frequently called copperas, should not be confused with copper sulfate which has the formula $CuSo_4$. As commonly purchased, ferrous sulfate has the formula $FeSO_4.7H_2O$. When used in coagulation, lime must usually be added to provide the alkalinity necessary for reaction, as follows:

Ferrous sulfate+hydrated lime=
ferrous hydroxide+calcium sulfate

$$FeSO_4+Ca(OH)_2=Fe(OH)_2+CaSO_4$$

However, oxygen must be available to change the $Fe(OH)_2$ to $Fe(OH)_3$, which is the desired coagulant:

ferrous hydroxide+water+oxygen
=ferric hydroxide

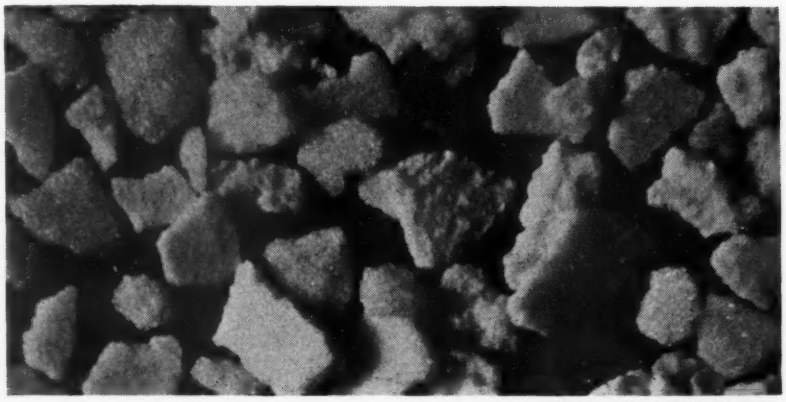
$$4Fe(OH)_2+2H_2O+O_2=4Fe(OH)_3$$

If chlorine is added to $FeSO_4$, ferric sulfate and ferric chloride are produced:

ferrous sulfate+chlorine=ferric
sulfate+ferric chloride

$$6FeSO_4.7H_2O+3Cl_2=2Fe_2(SO_4)_3+2FeCl_3$$

It will be interesting to the student to compute how much chlorine is needed to react with each pound of ferrous sulfate in the above solution, remembering that the formula for fer-



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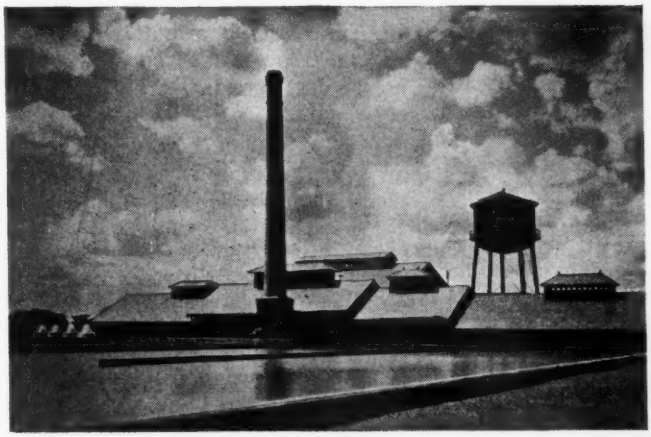

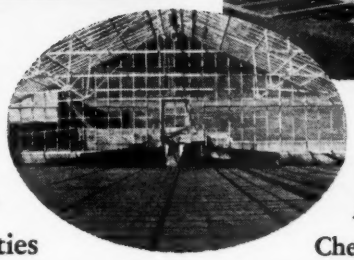

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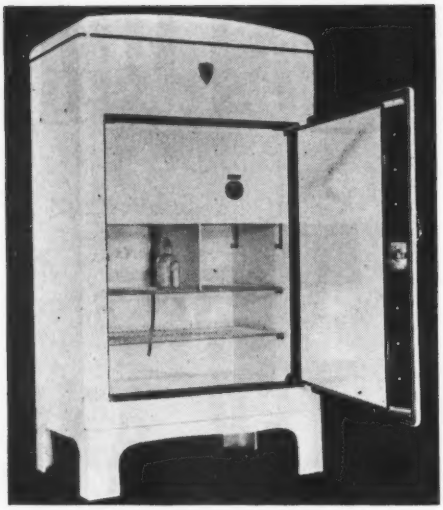

Precision Scientific Co. laboratory incubator.

rous sulfate is $FeSO_4.7H_2O$ and that an allowance must be made for the weight of the water in the hydrate. He should use the atomic weights previously given and either neglect the right half of the equation or allow for $42H_2O$ in balancing it, this being due to the $7H_2O$ contained in each unit of the $FeSO_4$.

The formula of ferric sulfate is $Fe_2(SO_4)_3.9H_2O$. Alkalinity is required for the reaction, and if the water or sewage does not contain enough alkalinity, it must be supplied by lime or soda ash. The reaction with hydrated lime is:

ferric sulfate+hydrated lime=
calcium sulfate+ferric hydroxide

$$Fe_2(SO_4)_3.9H_2O+3Ca(OH)_2=3CaSO_4+2Fe(OH)_3$$

In practice, the alkalinity of the water should be determined by the appropriate simple tests, and any deficiency supplied by adding lime or soda ash. To determine the amount of lime to be added, proceed as follows:

H_2O, atomic weight 18.02 x 9	=	162.18
Fe, atomic weight 55.84 x 2	=	111.68
SO_4, atomic weight 96.06 x 3	=	288.18
Total weight $Fe_2(SO_4)_3$		562.04
Ca, atomic weight 40.08 x 3	=	120.24
$(OH)_2$, atomic weight 34.02 x 3	=	102.06
Total weight of lime $Ca(OH)_2$		222.30

If there is no alkalinity in the water, 222.3 pounds of hydrated lime will be required for each 562.04 pounds of ferric sulfate of the formula $Fe_2(SO_4)_3.9H_2O$. If the amount of ferric sulfate applied is 1 grain per gallon, or 142.9 pounds per million gallons, the amount of hydrated lime required will be 222.3 x (142.9÷562.04)=56.5 pounds of 100% hydrated lime. If the lime is 95% pure, about 60 pounds will be required.

It is perhaps more often the case that some alkalinity is present in the water, but not enough for the reaction to take place. Assuming that there are 5 ppm of natural alkalinity in the water, the reaction with ferric sulfate will be:

ferric sulfate+bicarbonate alkalinity
=calcium sulfate+ferric hydroxide
+carbon dioxide

$$Fe_2(SO_4)_3+3Ca(HCO_3)_2=3CaSO_4+2Fe(OH)_3+6CO_2$$

Alkalinity is computed as calcium carbonate, $CaCO_3$, and the ferric sulfate will require 3 x (40.08+12.01+48.00)=300.27 pounds of calcium carbonate for each 562.04 pounds of ferric sulfate. For a dosage of 1 gpg, there will be required 300.27 (142.9÷462.04)=76.2 pounds per million gallons. If there are 5 ppm. of natural alkalinity available in the water, this amounts to 5 x 8.34=41.7 pounds, and only 76.2—41.7=34.5 pounds per million gallons of alkalinity must be added. The relation, by atomic weights, between calcium carbonate and hydrated lime is 100.09:74.01, and there will be required 34.5÷.74=46.6 pounds of hydrated lime per million gallons. In practice, however, some excess alkalinity is desirable; also many factors, as temperature, mixing, etc., affect the reaction; and computations cannot be made as closely as the theoretical problem given. Probably a residual alkalinity of 10 to 20 ppm. would be desirable and the dosage of lime would be increased accordingly.

Ferric chloride is available in lump form, the formula being $FeCl_3.6H_2O$, and also in solution. The concentration in solution varies because of the relation between temperature and crystallization, and is about 40%, falling to 35% in cold weather. An anhydrous form is also available.

Reactions in coagulation are covered in some detail in PUBLIC WORKS for September, 1938, in "The Operation of Sewage Treatment Plants."

The amount of lime or natural alkalinity required is shown by the equation:

$$2FeCl_3 + 3Ca(OH)_2 = 2Fe(OH)_3 + 3CaCl_2$$
$$2FeCl_3 + 3Ca(HCO_3)_2 = 2Fe(OH)_3 + 3CaCl_2 + 6CO_2$$

The atomic weights of the iron and of the hydrated lime are, remembering that ferric chloride contains 6 atoms of water of crystallization:

Fe, 55.84 x 2	111.68	Ca, 40.08 x 3	120.24
Cl_3, 35.46 x 6	212.76	$(OH)_2$, 34.02 x 3	
H_2O, 18.02 x 12	216.24		102.06
	540.68		222.30

Therefore, 222.3 pounds of hydrated lime will be required to react with 540.68 pounds of ferric chloride, and the amount of lime required can easily be computed for any dosage of ferric chloride. In computing the requirements for natural alkalinity, which is based on $CaCO_3$, the same procedure as for ferric sulfate is employed.

Hypochlorites. — Hypochlorites of calcium or sodium are used for various purposes, as for sterilizing newly laid mains, chlorinating small water supplies and for similar purposes. The formula for calcium hypochlorite is $Ca(ClO)_2$, and for sodium hypochloriteNaClO. With these formulas, the molecular weight of the calcium compound is 40.08+70.92+16.00=127, and the chlorine content may be 70.92 ÷127=about 55%; for the sodium compound, the weight is 23.00+35.46 +16.00=74.46, and the chlorine content is 35.46÷74.46=about 46%. Actually, ordinary forms of hypochlorite contain 25% to 30% of available chlorine, but HTH and Perchloron contain about 70%. There is great variety of hypochlorite formulas in actual use and the above are given merely as being typical forms.

Activated carbon differs from other chemicals in that its value is measured by what it accomplishes rather than its chemical analysis. The action of activated carbon is by adsorption, which comes under the branch of physical chemistry. When activated carbons absorb impurities from solution, these impurities are actually removed rather than changed by chemical reaction from one compound to another. Activated carbon has the characteristics of removing organic compounds and occasionally inorganic compounds from solution. It is for this reason that the primary application of activated carbon in the water and sewage field is for control of odors.

Other Chemicals.—Other chemicals or compounds employed or encountered in water and sewage work include the following:

$CuSO_4$, copper sulfate, used in algae control.

NH_3, ammonia, found in sewage; also used with chlorine for water treatment.

NH_3Cl or $NHCl_2$, chloramine, used in water treatment.

SO_2, sulfur dioxide, used for various purposes in water treatment.

SO_3, sulfite, does not occur alone, but in combination with a base, as Na_2SO_3, sodium sulfite.

SO_4, sulfate, combines with H to form sulfuric acid, or with a base to form a salt, as $CaSO_4$, calcium sulfate.

NO_2, nitrite, found in water and sewage.

NO_3, nitrate, found in water and sewage.

SiO_2, silica, silcion dioxide, or silicate.

OH, hydroxide, as KOH, potassium hydoxide, a laboratory reagent.

$BaCl_2$, barium chloride, a laboratory reagent.

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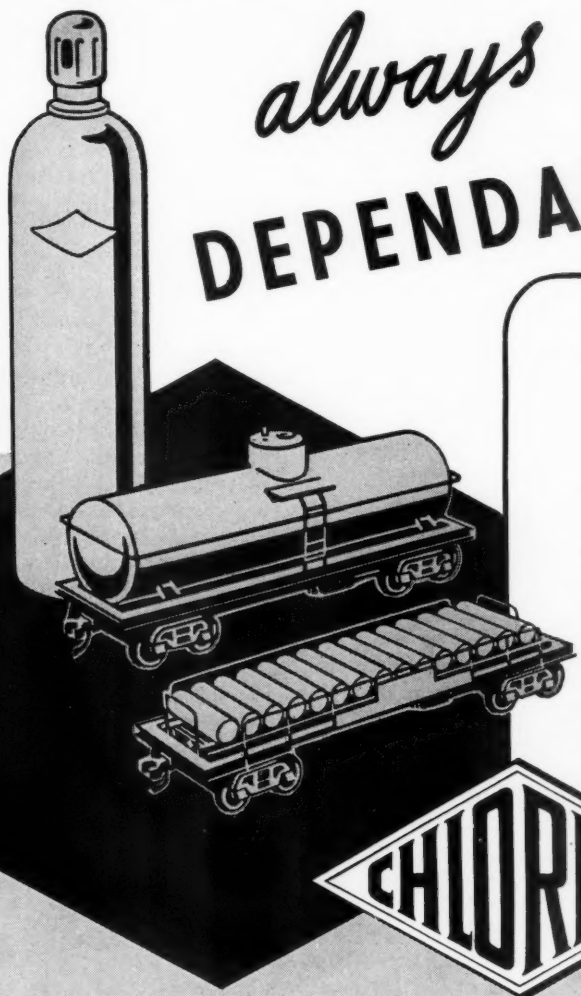

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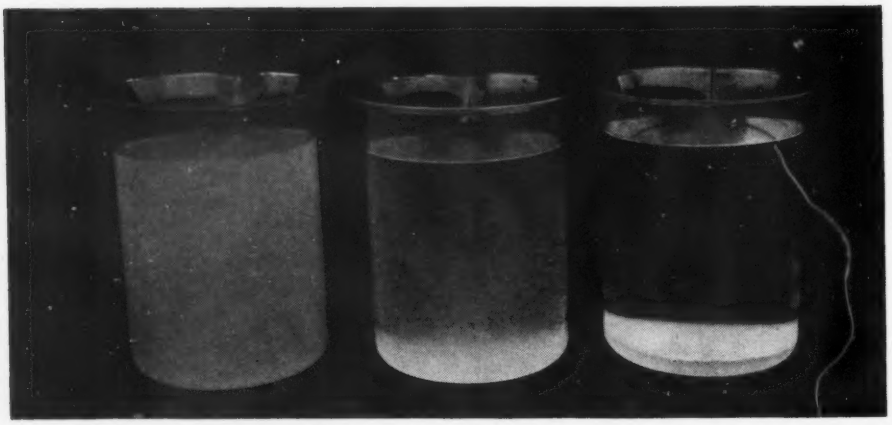

Demonstration of effective coagulation and clarification of an industrial waste by means of aluminum sulphate.

Making Standard Solutions

A standard solution is one that contains a known weight of the substance under consideration in a definite volume of solution. Standard solutions are an absolute necessity in making analyses, and such solutions are usually expressed in terms of the *normal* system. An 0.02N, or an N/50 solution (also called a fiftieth normal) is a solution that is one-fiftieth as strong as a normal solution. A 5N solution is five times as strong as a normal solution. To understand fully the normal system, some explanations and a few definitions are necessary.

The *gram-atomic* weight of a substance is the atomic weight of that substance expressed in grams. For example (see table of atomic weights) the atomic weight of sulfur is 32.06, and the gram-atomic weight is 32.06 grams. The atomic weight of sodium is 23.00 and the gram-atomic weight is 23.00 grams.

The *gram-molecular* weight of a substance or compound is the sum of the gram atomic weights of the elements that make it up. For instance, the molecular weight of sulfuric acid, H_2SO_4, is 2.02+32.06+64.00=98.08, and the gram-molecular weight is 98.08 grams. The gram-molecular weight of sodium carbonate, Na_2CO_3, is 46.00+12.01+48.00=106.01 grams.

The gram-equivalent weight of a compound is computed from these. For acids, the gram-equivalent weight is the gram-molecular weight divided by the number of replaceable hydrogen atoms that they contain. For instance, H_2SO_4 contains two replaceable hydrogen atoms, and the gram equivalent weight is the gram-molecular weight divided by 2; that is, it is 98.08÷2=49.04. For bases, the gram-molecular weight is divided by the number of hydrogen or hydroxl ions entering into the neutralizing reaction. For instance, Na_2CO_3 has the equivalent of two ionizable hydrogen atoms (that is the two Na ions can be replaced by two H ions) and the gram-equivalent weight is therefore 106.01÷2=53.00.

The gram-equivalent weights of various compounds more or less frequently used in the water and sewerage field are as follows:

	Compound	*Formula*	*Molecular Weight*	*Gram-Equivalent Weight*
(1)	Aluminum sulfate	$Al_2(SO_4)_3$	342.14	57.02
(2)	Calcium carbonate	$CaCO_3$	100.08	50.04
(3)	Calcium oxide	CaO	56.08	28.04
(4)	Calcium sulfate	$CaSO_4$	136.14	68.07
(5)	Ferrous sulfate	$FeSO_4$	151.90	75.95
(6)	Ferric chloride	$FeCl_3$	162.21	54.07
(7)	Hydrochloric acid	HCl	36.47	36.47
(8)	Hydrogen sulfide	H_2S	34.08	17.04
(9)	Nitric acid	HNO_3	63.02	63.02
(10)	Sodium carbonate	Na_2CO_3	106.01	53.00
(11)	Silver nitrate	$AgNO_3$	169.89	169.89
(12)	Sodium hydroxide	$NaOH$	40.01	40.01
(13)	Sulfuric acid	H_2SO_4	98.08	49.04

These gram-equivalent weights are given in most chemistry texts, or they may be computed. Considering aluminum sulfate, the molecular weight is obtained by adding the atonic weights of the elements that make it up; the number of equivalent ionizable hydrogen atoms can be determined by inspection. For instance we know that SO_4 and 2H combine to form H_2SO_4. There SO_4 will combine with two hydrogen ions. In $Al_2(SO_4)_3$, the Al_2 combines with three SO_4 and therefore it must be equivalent to 6H ions. Thus the gram equivalent weight is 342.14 ÷6=57.02.

Since Ca can be replaced by H_2 (or 2H), the factor in lines 2, 3 and 4 is 2 and gram equivalent weights are one-half the molecular weights. In line 6, we remember that H and Cl combine, whereas Fe combines with 3Cl, when the gram-equivalent weight is the molecular weight divided by 3. In lines 7, 9, 11 and 12, there is only a single H and the molecular and gram equivalent weight are the same.

Normal Solutions.—A normal solution contains one gram-equivalent weight of that substance in a liter of solution. A normal solution of sulfuric acid (see Line 13), therefore, contains 49.04 grams of pure sulfuric acid in one liter of solution; usually it is added to distilled water to make up the required quantity of one liter. Likewise a normal solution of calcium carbonate contains 50.04 grams (see Line 2) of the pure calcium carbonate in one liter of solution. A milliliter (or a liter, quart, etc.) of one of these solutions will exactly neutralize a milliliter (or liter, quart, etc.) of the other.

An 0.02N a fiftieth normal or an N/50 solution of sulfuric acid will contain 1/50 of 49.04 grams or 0.98 gram of pure sulfuric acid in 1 liter. In the case of calcium carbonate, one liter of an N/50 solution will contain 50.04÷50 or almost exactly 1.00 gram of pure calcium carbonate.

A tenth normal (0.10 or N/10) solution of sulfuric acid will contain 4.904 grams of pure acid in a liter of solution; a normal solution, as already slated, will contain 49.04 grams; a 10N solution will contain 490.4 grams, etc.

The preparation of these normal solutions must begin with some material that can be obtained in a pure state; sodium carbonate is usually employed initially. A solution of normal or less than normal strength is obtained by weighing out the required amount, and this is diluted as desired. From this standard solution, sulfuric acid and other solutions are made up by checking against the original. The procedure requires some practice and skill in handling chemicals and chemical equipment. A particularly clear description of the detail procedure to be followed is given in Theroux, Eldredge & Mallman's book. It is better for the small sewage or water plant laboratory without a trained chemist to purchase solutions of definite strength already made up.

Solutions may change in strength as time passes, and they should be checked by titrating them against solutions of known strength, and their variation from normal determined and corrected for in subsequent calculations. Titration means adding measured small quantities of the standard until

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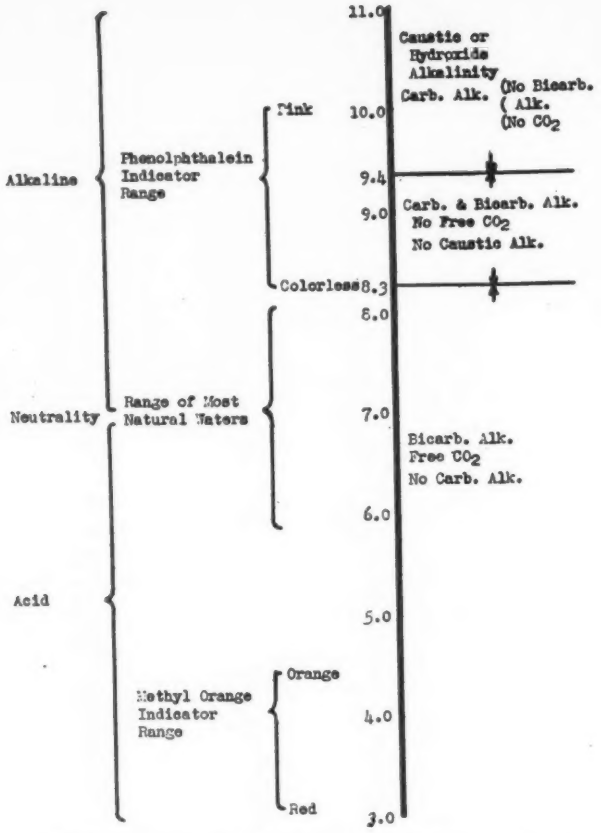


Calc Carb least soluble at pH 9.4—13 ppm in solution
Mg Hydrox least soluble at pH 10.6—3 ppm $MgOH_2$ in solution

a definite end-point is shown. In actual laboratory practice, solutions are not always kept at exact normal strength, but their actual strength is known and allowances made for this in the computations.

Molar Solutions.—A molar solution of a substance is a solution that contains one gram-molecular weight of the substance in one liter of solution. As already stated, the gram - molecular weight is the sum of the gram-atomic weights of the elements that make up the command. Molar solutions are indicated by strength in the same way that normal solutions are indicated; that is, 0.01M or M/100; M/50; 10M. etc.

An Ml solution, that is a molar solution, of sulfuric acid contains 98.08 grams of the pure acid in one liter; an 0.02M solution (M/50 solution) contains 1.9616 grams; and an 0/01M (M/100) solution contains 0.98 gram, or exactly the same as an N/50 solution. In the case of H_2SO_4, Na_2CO_3 and other compounds that have two replaceable hydrogen atoms, the Molar solution is twice as strong as the Normal solution, and an M solution equals a 2N solution. In the case of those compounds that have but one replaceable hydrogen atom, as HNO_3, HCl and NaOH, the gram equivalent weight is the same as the gram molecular weight, and the Molar and Normal solutions are of equal strength.

Chemical Tests.—It is not the purpose of this text to explain the procedure in making chemical tests, for which "Standard Methods" or the excellent text by Theroux, Eldridge and Mallman should be followed, but it is desirable to be familiar with the various terms used in connection with them. General methods employed in testing include qualitative analyses, which are made to determine what elements or compounds are present, and quantitative analyses which are made to determine the amounts present.

Before attempting to determine the amount of chemical compounds present, it is necessary to determine the kind of compounds that are in the sample. In many cases, a qualitative analysis is all that is necessary, but in other cases it will serve as a guide to the methods to be employed for further testing. A very simple form of qualitative analysis is the addition of orthotolidine solution to water to determine if chlorine is present. The presence of color indicates that chlorine is present; and, as a matter of fact, this test is quantitative also, since the intensity of color indicates the amount of chlorine in the water; and the method of analysis is colorimetric.

Gravimetric quantitative analyses are made by weighing the amount of compound that is present in the sample, the compound first being changed by appropriate methods so that it is insoluble and easily separated. For example, the determination of sulfur in a sample of sewage involves changing the sulfur to sulfate and combining it with a soluble salt of lead or barium. The resulting compound is insoluble and can be removed by filtration and weighed, permitting the amount of sulfur in the original sample to be calculated.

Volumetric quantitative analyses are made by adding a chemical of known concentration or strength to an exact quantity of the sample. The volume of the reagent required for the desired reaction permits the amount of chemical in the sample to be calculated. For example, the alkalinity of water is determined by adding to a sample of 100 ml. (after phenolphthalein or methyl orange indicator has been added) N/50 sulfuric acid until a color change is noted. The alkalinity of the water, expressed in parts per million, is 10 times the number of milliliters of N/50 sulfuric acid required to produce the color change.

Colorimetric quantitative analyses involve the determination of the amount of unknown chemical in the sample by matching the color produced by adding the same chemical to a set of samples containing a known amount of the chemical being tested for, or by artificial color standards. This method is valuable in determining the presence and amounts of minute quantities of chemicals. For example, nitrites in water or sewage can be determined by adding a chemical that produces a distinct color in the sample; and matching this color with that produced by adding the same chemical to previously prepared tubes containing known amounts of nitrates.

Turbidimetric analyses are used in determining the amount of turbidity present in a sample by matching it with a series of suspensions of known turbidity. This is illustrated in the use of the familiar turbidity samples.

Alkalinity and Acidity; Hardness

General.—Water may be acid or alkaline; hard or soft; or may contain some or even many kinds of dissolved materials. This is to be expected from the fact that water is a good solvent and that in its travels over or through the ground it may pick up much material that is soluble. When present in only small quantities, these substances may not be objectionable; but acid waters may be corrosive to piping; hard water is unpleasant to use; and iron may discolor porcelain plumbing fixtures and interfere with certain manufacturing processes, such as laundries and dyeing plants.

These qualities in water are measured by means of several tests which, in some cases have enough relation to each other to cause confusion. A particular instance is the broad use of the term "alkalinity." This term is used as the opposite of "acidity" in connection with pH or hydrogen-ion tests; and it is also used to designate the amount of certain dissolved minerals which the water may contain.

For example, a pH reading of 9.0 indicates that the water is alkaline, but there is no relation between a pH of 9.0 and an alkalinity of 9. As a matter of fact, a water may be acid, as judged from the pH scale, with a reading of 6.2 or 6.5 or more or less, and still have an alkalinity of 100 or 200 ppm., or even more. The pH measurement is one of *intensity* of acidity or of its opposite, alkalinity, or anti-acidity, to manufacture a term. The alkalinity of 9 means that the water contains 9 ppm. of some kind of hydroxides, carbonates or bicarbonates, measured as $CaCO_3$.

There is a relation between pH and alkalinity in that there are three kinds of alkalinity which exist in certain pH ranges. The kinds of alkalinity are: a. Bicarbonate alkalinity, when alone, exists in the pH scale only below 8.3; b. Carbonate alkalinity which is present above pH 8.3; and c. Hydroxide or caustic alkalinity which is present above pH 9.4. Bicarbonate alkalinity is HCO_3; carbonate alkalinity is CO_3; and hydroxide alkalinity in OH.

Aside from this, for the purpose of this section of this text, pH readings can and will be generally neglected, and alkalinity will always refer to the *amount* of carbonate or bicarbonate compounds in the water in terms of parts per million.

Hardness is of two kinds, carbonate hardness, sometimes called temporary hardness because part of it is removable by boiling; and non-carbonate hardness, also called permanent hardness because it is not affected by boiling. Carbonate hardness is due to calcium and magnesium carbonates and bicarbonates; the calcium carbonate is insoluble except for a residual of between one and two grains per gallon, so that partial softening is obtained by changing these bicarbonates to carbonates. Non-carbonate hardness is caused by calcium and magnesium sulfates and chlorides.

Salinity in water is objectionable when present in excessive amounts. This is rarely the case in the eastern part of the United States, but many waters of the western states have a noticeable salinity. This is caused by the presence of potassium and sodium sulfates, chlorides and nitrates, and by the same compounds that cause non-carbonate hardness.

The compounds that cause alkalinity, hardness and salinity may be grouped as follows:

1. Those that cause alkalinity only:

Potassium carbonate, K_2CO_3
Potassium bicarbonate, $KHCO_3$
Sodium carbonate, Na_2CO_3
Sodium bicarbonate, $NaHCO_3$

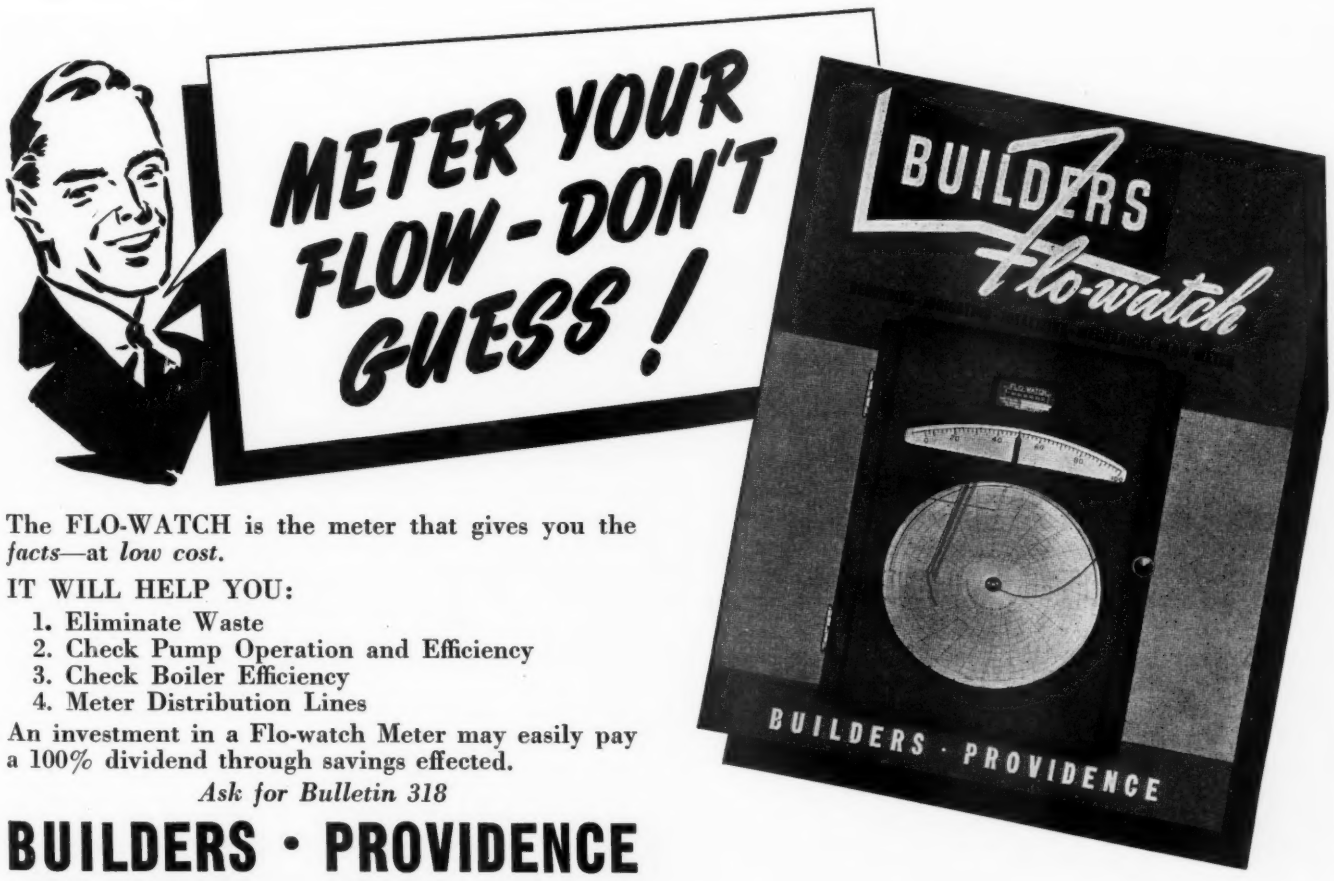
2. Those that cause both alkalinity and carbonate hardness:

Calcium carbonate, $CaCO_3$
Calcium bicarbonate, $Ca(HCO_3)_2$
Magnesium carbonate, $MgCO_3$
Magnesium bicarbonate, $Mg(HCO_3)_2$

It will be noted that the potassium and sodium compounds do not cause hardness, but that all carbonates and bicarbonates cause alkalinity, while all calcium and magnesium compounds cause hardness, whether in the carbonate, bicarbonate, sulfate or chloride form, as shown below:

3. Those that cause both salinity and non-carbonate hardness:

Calcium sulfate, $CaSO_4$
Calcium chloride, $CaCl_2$
Magnesium sulfate, $MgSO_4$
Magnesium chloride, $MgCl_2$



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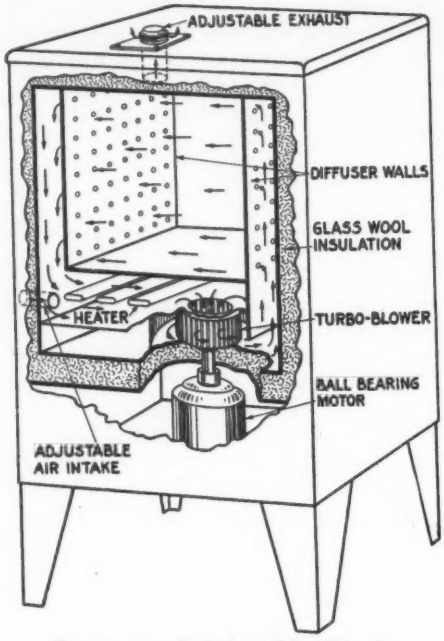


Freas oven, Precision Scientific Co.

4. Other salts that cause salinity, but not hardness:

Potassium sulfate, K_2SO_4
Potassium chloride, KCl
Potassium nitrate, KNO_3
Sodium sulfate, Na_2SO_4
Sodium Chloride, NaCl
Sodium Nitrate, $NaNo_3$

Caustic alkalinity occurs when there is an excess of lime in the water and this excess may precipitate in the distribution system or on the sand of a filter bed as $CaCO_3$. Caustic alkalinity does not occur in a natural water.

Acidity in water is caused by free CO_2, by mineral acids, by iron or aluminum sulfates and by some other less common compounds.

Analyses and Tests.—The basic tests for alkalinity are those for phenolphthalein alkalinity and for methyl orange alkinity. The method of performing these tests will not be described here as there are a number of excellent texts available describing the procedures in detail.

The phenolphthalein and methyl orange alkalinity determinations show the kinds of alkalinity that are present in the water. Phenolphthalein measures none of the bicarbonates, half of the normal carbonate and all of the hydroxide alkalinity; and methyl orange measures the total of all alkalinity. All alkalinity is measured in terms of $CaCO_3$. The relationships between these three kinds of alkalinity are shown in the following examples:

a. If the alkalinity to phenolphthalein is 0, that is, there is no color reaction to the addition of the phenolphthalein indicator solution, there is no caustic alkalinity and no carbonate alkalinity, but the alkalinity to methyl orange as shown by the test represents the bicarbonate alkalinity.

Example: Alkalinity to phenolphthalein is 0.0 p.p.m.; and to methyl orange is 18.5 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 0; and bicarbonate alkalinity is 18.5 p.p.m.

b. When the alkalinity to phenolphthalein is less than one-half the alkalinity to methyl orange, there is no caustic alkalinity; the carbonate alkalinity is twice the phenolphthalein alkalinity; and the bicarbonate alkalinity is the methyl orange alkalinity minus twice the phenolphthalein alkalinity.

Example: Alkalinity to phenolphthalein is 28.0 p.p.m.; and to methyl orange 86.0 p.p.m. Caustic alkalinity is 0; carbonate alkalinity is 56.0 p.p..m. and bicarbonate alkalinity is $86 - (2 \times 28) = 30$ p.p.m.

c. When the phenolphthalein alkalinity is exactly one-half of the methyl orange alkalinity, the caustic alkalinity is 0, the carbonate alkalinity is the same as the methyl orange alkalinity, and the bicarbonate alkalinity is 0.

Example: Phenolphthalein alkalinity is 72.0 p.p.m. and methyl orange alkalinity is 144.0 p.p.m. The caustic alkalinity is 0.0 p.p.m.; the carbonate alkalinity is 144.0 p.p.m.; and the bicarbonate alkalinity is 0.0 p.p.m.

d. When the phenolphthalein alkalinity is more than one-half of the methyl orange alkalinity, caustic alkalinity is twice the phenolphthalein alkalinity minus the methyl orange alkalinity; the carbonate alkalinity is twice the difference between the methyl orange and phenolphthalein alkalinities; and the bicarbonate alkalinity is 0.

Example: The phenolphthalein alkalinity is 150 p.p.m.; the methyl orange alkalinity is 196 p.p.m. The caustic alkalinity is $2 \times 150 - 196 = 104$ p.p.m.; the carbonate alkalinity is $(196 - 150)\ 2 = 92$ p.p.m.; bicarbonate alkalinity is 0.

e. When the phenolphthalein and methyl orange alkalinities are the same, all the alkalinity is caustic alkalinity and carbonate and bicarbonate alkalinities are 0.

Example; Phenolphthalein alkalinity is 120: alkalinity to methyl orange is 120. Hydroxide alkalinity is 120, and carbonate and bicarbonate alkalinities are 0.

Water Softening.—There are two principal methods of water softening —the lime or lime-soda process and the use of zeolites. These will be discussed separately and only from the viewpoint of the elementary chemical procedures involved. As a basis for lime-soda softening, certain tests are necessary.

The test for total hardness measures the amount of calcium and magnesium compounds, which include those causing carbonate as well as non-carbonate hardness. That is, total hardness tests will show the amounts of the compounds listed under 2 and 3 preceding.

The test for hardness, with the analyses for phenolphthalein and methyl orange alkalinity, permit the computation of many other factors showing information on the characteristics of the water.

When total hardness and alkalinity are the same, calcium and magnesium bicarbonates and carbonates produce all of the hardness, which is carbonate hardness. Example: Alkalinity to methyl orange 60; total hardness 60. All hardness is due to the compounds of calcium and magnesium listed under 2 preceding.

When total hardness exceeds alkalinity, the hardness is made up of the carbonate hardness, which equals the alkalinity, and the non-carbonate hardness which equals the total hardness less the alkalinity. Example: Total hardness 80; alkalinity 60; non-carbonate hardness is $80 - 60 = 20$; carbonate hardness is 60. In this case, the compounds listed under 2 and 3 preceding.

When the total hardness is less than the alkalinity, there is no non-carbonate hardness, and the difference between the total hardness and alkalinity measures the amount of sodium and potassium carbonates that are present. Example: Total hardness 60; alkalinity 80. All of the hardness is carbonate hardness (2 preceding); and there are $80 - 60 = 20$ parts of sodium and potassium carbonates and bicarbonates (1 preceding).

In water softening, these sodium and potassium carbonates and bicarbonates can be neglected, as they do not affect hardness. In analyses, these are stated as negative non-carbonate hardness and are subtracted from the alkalinity to show total hardness.

Reactions in Softening.—As already stated, the carbonate hardness is due to the presence of calcium and magnesium bicarbonates and carbonates, but the calcium carbonate is only slightly soluble in water—only to the extent of about 20 to 30 p.p.m. In excess of this amount, the carbonates are insoluble and will precipitate or settle out. Therefore, by changing the bicarbonates to carbonates, carbonate hardness can be reduced to about 30 p.p.m. This can be accomplished by adding lime which combines with the CO_2 in the bicarbonates and converts them to normal carbonates. The reaction for cal-

cium bicarbonates when lime is added is as follows:

Calcium bicarbonate + hydrated lime = calcium carbonate + water

$$Ca(HCO_3)_2 + Ca(OH)_2 = 2CaCO_3 + 2H_2O$$

The reaction with magnesium is the same, but since $MgCO_3$ is too soluble, it is converted to $Mg(OH)_2$ by the addition of more lime.

The addition of an excess of lime produces caustic alkalinity; and when magnesium is present forms magnesium hydroxide, which precipitates in large white flakes.

Magnesium Carbonate ($MgCO_3$) + Magnesium Sulfate ($MgSO_4$) + Lime ($(Ca(OH)_2$) = Magnesium hydroxide ($Mg(OH_2)$ + $CaCO_3$ + $CaSO_4$

The non-carbonate hardness can be removed by soda ash, as follows:

Calcium sulfate + sodium carbonate = calcium carbonate + sodium sulfate

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

The insoluble calcium carbonate precipitates (except for 1 to 2 gpg., as already stated) and the sodium sulfate remains in solution, merely increasing the salinity of the water.

In lime softening computations, analyses are required to show free CO_2, half-bound CO_2, non-carbonate hardness and total magnesium. Lime must be added to react with all of these. Half-bound CO_2 equals 44% of the alkalinity, as follows: The atomic weight of $CaCO_3$ is 100, and of CO_2 is 44, which is 44% of the weight of $CaCO_3$.

a. The amount of lime theoretically required to react with CO_2 is determined by adding together the free CO_2 and the half-bound CO_2, expressed in parts per million and multiplying by a factor which is determined as follows: The atomic weight of $CaCO_3$, which is the compound into which it is desired to convert the CO_2 by the addition of lime, is $40.08 + 12.01 + 48.00 = 100.09$, of which the weight of CO_2 is 44.01, and of CaO is 56.08. For each part per million of CO_2 present, there will be required $56.07 \div 44.01 = 1.272$ parts of CaO. Since 1 p.p.m. equals 8.34 pounds per million gallons, $8.34 \times 1.272 = 10.6$ pounds of lime for each part per million of CO_2, whether free or half-bound, per million gallons of water. (These data are for lime with 100% CaO.)

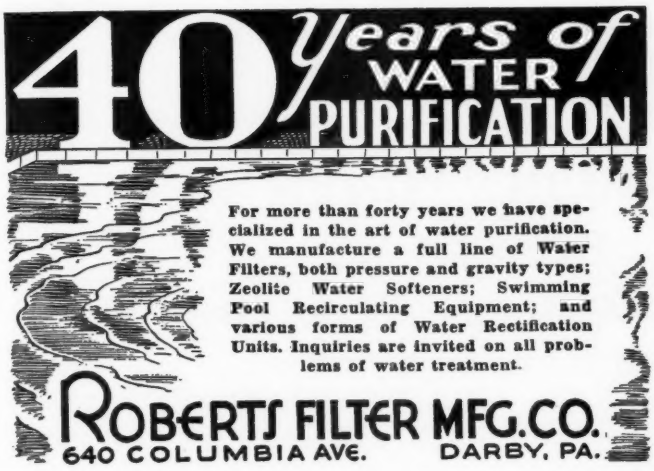
b. Soda ash is required to remove non-carbonate hardness, which it does by converting the calcium sulfates and chlorides to calcium carbonates and sodium sulfates and chlorides. Since the non-carbonate hardness is expressed by the tests as parts per million of $CaCO_3$, for each p.p.m. of non-carbonate hardness, there will be required $46 + 12.01 + 48 = 106.01$ (the atomic weight of Na_2CO_3) divided by 100.00 (the atomic weight of $CaCO_3$), or $106.01 \div 100.08 \times 8.34 = 8.84$ pounds per million gallons for each part per million of non-carbonate hardness.

c. The removal of magnesium is accomplished by adding lime. The analysis shows total magnesium. This must be changed by the addition of lime to magnesium hydroxide ($(Mg(OH)_2$). This hydroxide alkalinity occurs at pH values above 9.4. The reactions are:

$$MgCl_2 + Ca(OH)_2 = CaCl_2 + Mg(OH)_2$$
$$MgCO_3 + Ca(OH)_2 = CaCO_3 + Mg(OH)_2$$
$$MgSO_4 + Ca(OH)_2 = CaSO_4 + Mg(OH)_2$$

The $Ca(OH)_2$ is, of course, hydrated lime, that is $CaO + H_2O$, but computations are on the basis of CaO.

Since the analyses show total magnesium, in any of the above forms, the amount of lime required is as the atomic weight of CaO and Mg, or 56.08 and 24.32, and for each part per million of Mg. there will be required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56.08 ÷ 24.32 = 2.36 p.p.m. of lime, or 2.36 x 8.34 = 19.67 pounds per million gallons. If there are 20 p.p.m. of total magnesium, 20 x 19.67 = 393.4 pounds of lime will be required per million gallons.

Example: The analyses of a water shows the following: Free CO_2, 2 p.p.m.; alkalinity 60 p.p.m.; non-carbonate hardness 55 p.p.m.; total magnesium 12 p.p.m. To determine the amount of chemicals required for treatment:

The first decision to be made is the amount of hardness to be removed. It is not generally desirable to remove all of the hardness; assuming it is desired to remove all but about 35 p.pm. of non-carbonate hardness, non-carbonate hardness to be removed is 55 — 35 = 20 p.p.m.

Lime will be used as follows: To neutralize CO_2, free and half-bound, 2 + (60 x .44) = 28.4 p.p.m. x 10.6 = 301.1 pounds per million gallons. To react with and remove the magnesium, 12 x 19.67 = 236 pounds per mg. Total lime required per million gallons = 301 + 236 = 537.

Soda ash required amounts to 20 x 8.84 = 176.8 pounds per million gallons.

If alum is used for coagulant, additional soda ash or lime may be required.

The computations are on the basis of 100% CaO in the lime and 100% $NaCO_3$. Corrections must be made for lower purities or contents.

The results obtained by these computations are subject, in actual practice, to variations and the theoretical computed dosage may not be exactly that actually needed. It is always desirable to check the calculated amounts of chemicals by means of jar tests, using one liter, a quart or a gallon of water and noting results.

Zeolite Softening.—Zeolites are hydrous silicates of sodium and aluminum, which have the ability of absorbing calcium and magnesium (the hardness causing elements) from water while releasing or exchanging an equal amount of sodium. The softening reaction, using Z for the zeolite compound is:

sodium zeolite + calcium bicarbonate = calcium zeolite + sodium bicarbonate

$$Na_2Z + Ca(HCO_3)_2 = CaZ + 2\ Na(HCO_3)$$

and

$$Na2Z + CaSO_4 = CaZ + 2\ Na_2SO_4$$

The same reaction occurs with magnesium. These materials are drawn from the water and sodium bicarbonate is returned. When the capacity of the zeolite to absorb calcium and magnesium is exhausted, a strong salt solution is passed through the zeolite, which then exchanges the absorbed calcium and magnesium for the sodium, after this process has been completed, the zeolite will again absorb the original quantity of calcium and magnesium. The reaction with the brine is:

Calcium zeolite + sodium chloride = sodium zeolite + calcium chloride

$$CaZ + 2NaCl = Na_2Z + CaCl_2$$

Carbonaceous zeolites remove sodium, magnesium and calcium, replacing these with hydrogen. In conjunction with ordinary zeolites, the carbonaceous zeolites control the alkalinity of the water. Reactions are, using Z for the zeolite:

$$Ca(HCO_3)_2 + H_2Z = CaZ + 2H_2CO_3$$
$$Mg(HCO_3)_2 + H_2Z = MgZ + 2H_2CO_3$$
$$Na_2(HCO_3)_2 + H_2Z = Na_2Z + 2H_2CO_3$$
$$CaSO_4 + H_2Z = CaZ + H_2SO_4$$
$$MgSO_4 + H_2Z = MgZ + H_2SO_4$$
$$Na_2SO_4 + H_2Z = Na_2Z + H_2SO_4$$

The zeolite is regenerated by sulfuric acid as follows:

$$\left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\}Z + H_2SO_4 = H_2Z + \left.\begin{matrix}Ca\\Mg\\Na_2\end{matrix}\right\}SO_4$$

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Maintenance in Wayne County

(Continued from page 13)

Signs and Pavement Marking:

The most use can be had from a highway system only when the roads and streets are marked with information and warning signs. Signs with road names, directions and distances to various towns and points of interest must be placed at intersections and other critical points. Traffic regulations and warning signs must also be placed along the highways to provide safety and convenience for the traveling public. Roads which are perfectly safe for travel in daylight without signs, are often very unsafe at night unless warning signs are properly placed. The value of signs for night driving is greatly increased by lighting or outlining the words or symbols with reflector buttons.

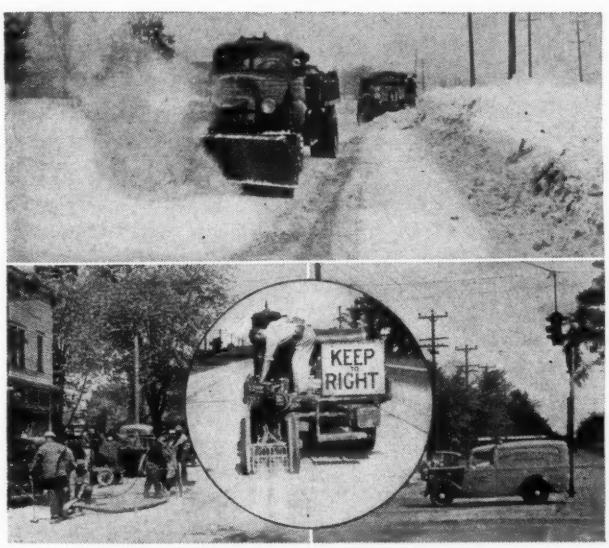
The use of pavement markings to warn and control traffic is also very important. The white centerline used to separate traffic lanes has provided more efficient and safe use of the highways. It is also important to keep crosswalk lines at school crossings and stop lines at intersections well painted to protect pedestrians.

Winter Maintenance:

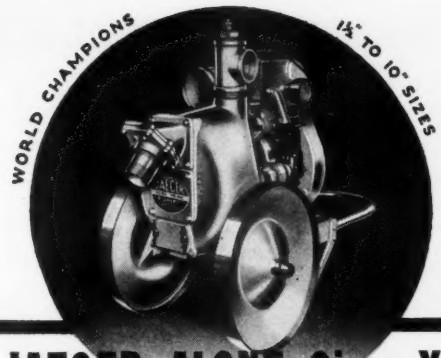
Snow and ice provide the most difficult maintenance problem in the winter time. During some winters this work is very light while at other times the organization is taxed to the limit to keep the roads in safe condition for travel. All trucks, snow plows and sanding equipment are prepared in the fall for this work and are kept in readiness for service twenty-four hours a day, seven days a week. Truck drivers and other labor are instructed to report to the maintenance yards for instructions at the first sign of snow, sleet or ice.

Sand and cinders, treated with calcium chloride, are stocked in piles at the various yards and other strategic points around the County. Sand boxes and barrels are filled and placed at curves, hills, grade separations and bridge approaches. This enables a more rapid covering of the icy roads in all sections of the County.

Immediately following a snowfall or during its duration if it is an extended snowfall, it is necessary to remove the snow from intersections, crosswalks and



Snow removal, raising sunken section by pumping, marking traffic line, and signal maintenance.



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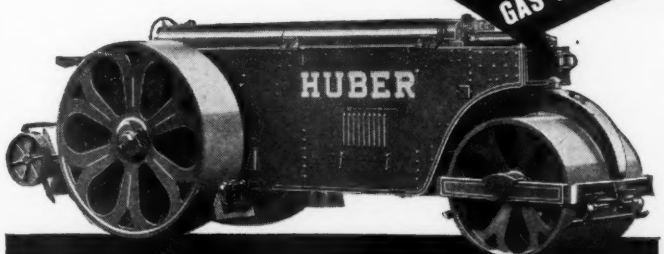

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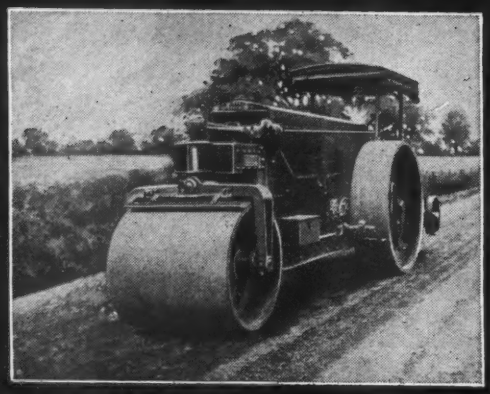

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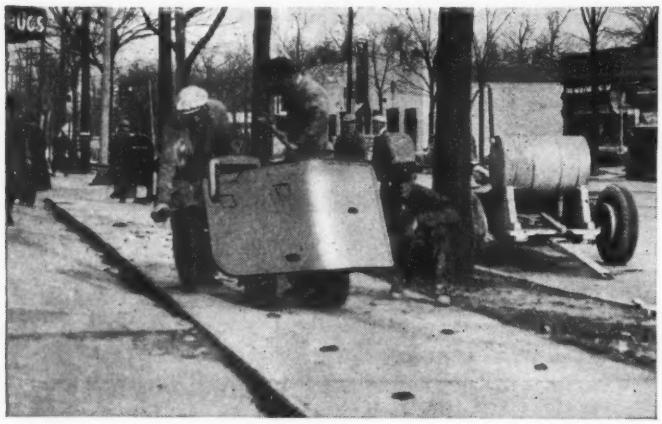

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Traffic Census:

In order to properly determine the traffic needs of the County road system it is necessary to study conditions at various locations. Much valuable information is obtained each year by taking counts of all vehicles using the highways at certain locations. Passenger cars, trucks and buses are separated in such counts and comparative importance of different roads is thus determined. These counts enable better planning for future work.

Permits and Truck Weighing:

The use of the highways for other purposes than traffic is common. Most homes in the County are now served at least with electricity and many of them with gas, telephone and sewers. The installation of all these lines, both underground and overhead, must be regulated. Upon application, permits are issued for all work to be done within the limits of a highway by utilities and other private or public parties. Inspection of this work must be made so that all damages can be repaired and the licensees charged for the same. Other work for which permits are required include the construction of driveways and curb cuts.

Provisions for the use of the highways by trucks, trailers and other unusual loads are definitely included in the State law relating to motor vehicles and the use of highways. This prevents undue damage to the roads because of excessive loads. A weighmaster, who is also a deputy sheriff, and equipped with portable scales, is continuously on the look-out for violators of the law. In cases of unusual loads which do not comply with the law as to size and weight, but which can be moved without damage to the roads, special moving permits are issued. These permits specify the route, speed and time the move may be made.

Betterments:

Conditions are changing so rapidly in Wayne County that often roads and streets which are adequate today will be inadequate tomorrow. This has been particularly true with respect to subdivision streets which had never been developed but where improvements became necessary to provide ingress and egress to new houses.

Improvement work which does more than maintain the existing condition of the highways, but is not of sufficient magnitude to be classed as new construction, is considered a betterment. This type of work is usually planned so that it can be done when regular maintenance work is at a minimum. Digging road drainage ditches and rebuilding inadequate culverts are two important items of this work.

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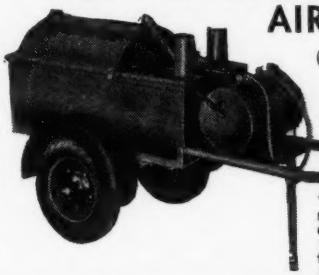

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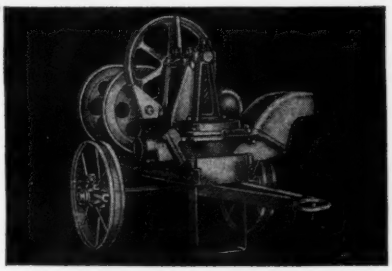

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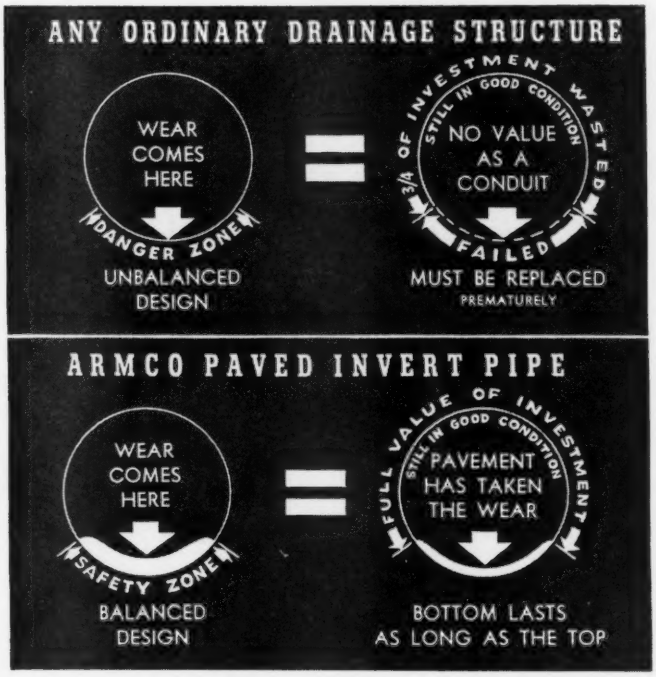

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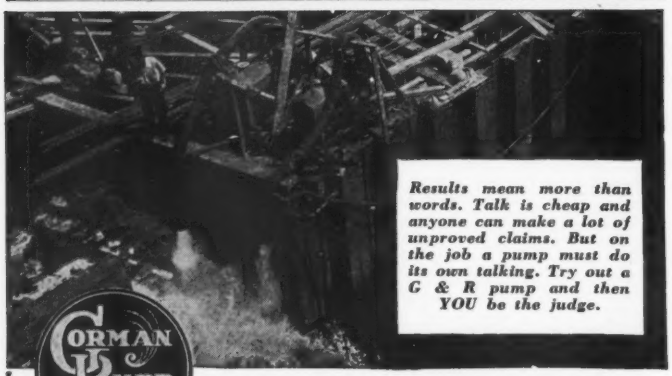
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Making Diversion of Automotive Tax Funds Illegal

Constitutional amendments were adopted by the states of Idaho, South Dakota and Nevada at the November 5 election which prevent the legislatures of those states from using taxes collected from motorists for non-highway purposes. Earlier in the year the state of North Dakota had ratified a similar constitutional amendment. This brings to eleven the number of states which now have such constitutional amendments. In addition, Iowa and Wisconsin have initiated legislative steps for submitting such amendments to the people for ratification. The states which had previously provided constitutional protection for highway funds were Missouri, Kansas, Minnesota, Colorado, California, Michigan and New Hampshire.

Last year, of the money collected from vehicle users of 34 of the states for gasoline taxes, registration fees and special motor carrier taxes, $181,654,000 was used for non-highway purposes. This is more than the annual appropriation for highways by the 1940 Federal Highway Act—$163,500,000.

Increasing Skid Resistance of Concrete

Treatment of concrete pavements with hydrochloric acid has resulted in a significant increase in the skid resistance quality of pavement in recent tests made in London, England. The etching caused by one gallon of acid increased the coefficient of friction for all areas up to 20 square yards. With one gallon per five square yards, the maximum concentration of the acid in the tests, the coefficient of friction was increased from .15 (at 30 miles per hour) to .70.

Filter and Pumping Plant for a Modern Institution

(Continued from page 15)

roofed over so as not to disturb the architectural plan of the campus. The control valves, automatic altitude valve and check valve (set for discharging but against filling) are located on the 11th floor of the tower.

Unique Features of the System

A number of the items in the system which have already been referred to are of unusual design and are described more in detail below.

Raw Water Intake.—In order to be able to withdraw water from the impounding reservoir at any level desired without constructing an expensive intake tower with its numerous sluice gates and operating stands, the consulting engineers have for many years used instead a riser 2 ft. high perpendicular to the upstream face of the dam near its base, on which is mounted a swivel elbow with a light intake pipe held up by steel trucks running on concrete tracks set in the face of the dam. Raising and lowering the intake along the surface of the dam is effected by a hand-operated crab mounted on the crest of the dam. On the end of the intake is a large basket screen which can be pulled above water for cleaning.

Vertical Flocculator.—The mixing chamber contains a flocculator which is not one of the patented articles and which is not adaptable to large plants which require a large area for the flocculating basin, but for plants under 2,000,000 gallons capacity they are eco-

nomical and have proved as effective as the horizontal type. This flocculator consists of paddles on a vertical shaft which is revolved by a 1½ hp electric motor through reduction gears and a Reeves variable speed drive giving from 1½ to 4½ rpm. There are no bearings or sprockets below the water surface except a hard rubber guide bearing at the base of the shaft.

Orifice and Float Valve Filter Rate Control.—The rate control system employed has been used by the authors for many years and always operated efficiently. There are no intricate mechanical parts which are difficult to repair and it has the added features of visibility and chlorine application to the filter effluents.

Filter Strainer System.—The filter strainer system is of a type which has been installed by the authors in about 24 filter plants, all in successful operation, and none has ever had to be uncovered for repairs. This is due largely to the use of only copper, concrete and glass in their construction, and the absence of small openings, the strainer openings being ½″ in diameter. The system consists of an inverted cone bottom of concrete blocks mounted on piers above the distributing area, the size of which permits the flow of water to all parts of the strainer system simultaneously and provides practically uniform pressure, and gives no dead spaces between the strainer openings. The strainers are of ½″ copper pipe, over each of which is an inverted glass trap which prevents the contact of gravel with the strainer openings and forces the downward flow of the wash water, which is intended to insure the cleaning of the lower portion of the strainer cell before upward motion takes place; also distributing the wash water over a considerable area and preventing jet action. The ½″ copper tube strainer rises approximately 1¾″ above the bottom of the inverted cone, which prevents loss of sand or other filter media, allowing it to collect on the bottom during filtering at low velocity and washing it upward into the filter bed at high velocity.

Combined Pumping Room and Pipe Gallery.—For economy in building construction and convenience of operation by one operator, the working units of the plant are placed in one room on the lower floor and one room on the upper floor, with observation openings between. These rooms contain all parts of the system except the water containers (such as clear well, settling basin and mixing chamber), coal storage, chemical storage and chemical feed. This is contrary to standard plant design but the writers have found it to more nearly fit the needs of the one-man operated plant and at a considerable saving of building construction, pipe and space.

The complete system was designed and built under the direction of Ralph C. Wyatt, Chief Engineer of Kentucky State Welfare Department, and Howard K. Bell, Consulting Engineers. The Bush Building Co. was the contractor for the plant and W. L. Hailey & Co. for the distribution system. The elevated storage tank was built by the Pittsburgh-Des Moines Steel Co. The main articles of equipment were supplied by the following manufacturers: Valves and fire hydrants, M & H Valve & Fittings Co.; Pumps, Dayton-Dowd Co.; Motors, General Electric Co.; Flow meter gauges, Minneapolis-Honeywell Regulator Co.; Heating & plumbing equipment, Crane Co.; Float valves, Davis Regulator Co.; Cast iron pipe, McWane Cast Iron Pipe Co.; Chlorinators & chemical dry feed machines, Wallace & Tiernan Co.; Meters, Neptune Meter Co.

This paper was begun by Howard H. Bell, recently deceased, and completed by his son, Grant S. Bell.

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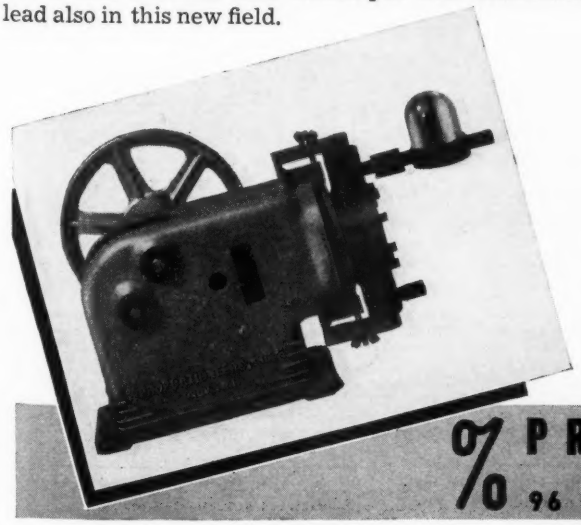

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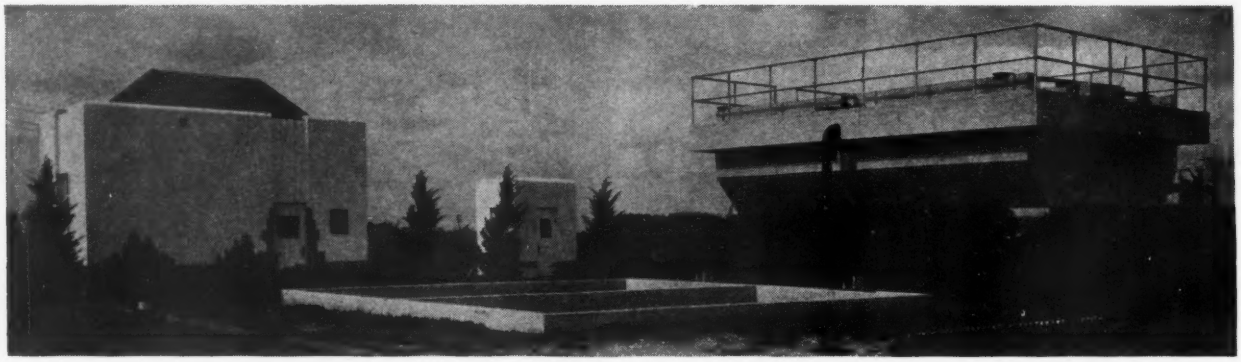

Pump house and laboratory of the Rayne, La., sewage treatment plant. Imhoff tank at right.

The Sewerage Digest

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Underground Discharge Of Sewage Effluents

Covina, Calif., 26 years ago voted a bond issue for sewerage and issued the bonds, but only last year were they able to overcome the obstacles of local prejudice and legal injunction, and then only by constructing a treatment plant which produced an unusually pure effluent. The site of the plant is not located on any stream or storm channel into which the effluent could be discharged, and the plans called for its use for irrigation or discharge into the ground through cesspools or drainage wells. So far most of it has been disposed of through wells. Treatment consists of screening, pumping to a primary clarifier, gravity flow to a trickling filter and recirculation of part to the pump pit. Part of the unreturned effluent is then dosed with ferric chloride and flows into a combination flocculating and clarifying tank, the remainder of it passing through a secondary trickling filter and being recirculated back to the secondary clarifier. Effluent from the flocculating-clarifying tank passes through two rapid sand filters, is then chlorinated and used for irrigation or discharged into underground percolating wells. The sand filters are at present operating at the rate of 0.5 gallon per sq. ft. per minute and are backwashed about once a day at the rate of 15 gal. per sq. ft. per minute. There are three drainage wells 6′ diameter by 65′ average depth in sandy loam, sand and gravel with intermittent clay strata. These wells are lined with leaching brick and were estimated to pass water into the ground at the rate of 44 gal. per sq. ft. per day, but during operation thus far the effluent has not risen more than 20 ft. above the bottom of the well, giving an average rate of percolation of 60 gallons per sq. ft.

This plant reduces the average BOD from 220 ppm in the raw sewage to 55 ppm in the primary clarifier effluent, 21 in the secondary clarifier effluent and 5 ppm in the plant effluent. Dissolved oxygen increases from an average of 2.3 ppm in the primary clarifier effluent to 7.6 in the plant effluent. Turbidities (using a Jackson turbidimeter) were reduced from about 800 in the raw sewage to 51 in the primary clarifier effluent, 28 in the primary filter effluent, and below 25 in all following effluents. The sludge is disposed of by two-stage digestion and drying on sludge beds. At the point where the effluent is discharged into the ground the depth of ground water is over 200′, beneath an impervious layer. There are no wells nearby that might be polluted.[C 77]

Storage Basins For Storm Sewers

Under some conditions of drainage area surface and size, comparative costs, etc., it may be cheaper to provide storage basins for temporarily holding excess run-off from short periods of peak intensity of rainfall than to build storm sewers of a capacity to carry such excess. The author calculates the capacities of storage basins required under different conditions, and concludes that consideration of storage, even if it is not adopted, results in a more complete analysis of the storm run-off; it provides additional facilities for securing run-off data; it may aid in acquiring areas for park purposes by offering the additional advantage of storm storage. It might be possible, in planning subdivisions, to set aside an area in each block or group of blocks for combined recreation and storage.[L10]

Simplified Designing of Brick Sewers

Fifty years ago the writer was informed in Pittsburgh, Pa., that only a few years previous decision as to the size of sewer to be placed in a business block had been based on the assessed valuation of the property facing it—the sewer was the largest that could be built for a sewer assessment figured at a standard rate. Apparently they have much more scientific methods there now. The accompanying table is one of three in an article entitled "Simplified Stress Analysis of Three-Ring Brick Sewers," written by an engineer in the Division of Design of that city.

TABLE I

Vousoir No. (1)	x (2)	y (3)	y^2 (4)	Horizontal Projection (5)	Vertical Projection (6)	Vertical Load Intensity (7)	Total Vertical Load + 0.2386 Dw (8)
1	.0782D	.0063D	0	.1845D + .1674	.0245D + .0265	dw + .0062Dw + .0087w	.1845Dw + .0010Dw² + .1674dw + .2400Dw + .0011w
2	.2370D	.0542D	.0030D²	.1394D + .1510	.0711D + .0770	dw + .0546Dw + .0860w	.1394Dw + .0078Dw² + .1510dw + .2344Dw + .0368w
3	.3988D	.1468D	.0215D²	.1106D + .1198	.1106D + .1198	dw + .1485Dw + .1587w	.1106Dw + .0161Dw² + .1198dw + .2732Dw + .0190w
4	.5448D	.2720D	.0748D²	.0711D + .0770	.1394D + .1510	dw + .2730Dw + .2857w	.0711Dw + .0194Dw² + .0770dw + .2800Dw + .0223w
5	.6899D	.4218D	.1779D²	.0365D + .0265	.1845D + .1674	dw + .4218Dw + .4560w	.0365Dw + .0103Dw² + .0265dw + .2804Dw + .0131w
	$\Sigma y = .9090D$		$\Sigma y^2 = .2760D^2$				

Vousoir No. (1)	Horizontal Load Intensity (9)	$\Delta p_1 - \Delta p_2$ (10)	$\Delta p_2 - \Delta p_3$ (11)	Total Horizontal Load (12)	Sum of Vertical Loads (13)
1	.3333dw + .0021Dw + .0022w	.1488D	.0484D	.0082Ddw + .0007Dw² + .0088dw + .0001Dw + .0001w	.1845Dw + .0010Dw² + .1674dw + .2400Dw + .0011w
2	.3333dw + .0183Dw + .0197w	.1368D	.0619D	.0237Ddw + .0018Dw² + .0257dw + .0028Dw + .0013w	.3239Dw + .0088Dw² + .3184dw + .4844Dw + .0380w
3	.3333dw + .0488Dw + .0529w	.0919D	.1260D	.0369Ddw + .0034Dw² + .0403dw + .0117Dw + .0063w	.4045Dw + .0247Dw² + .4382dw + .7676Dw + .0569w
4	.3333dw + .0910Dw + .0989w	.0484D	.1488D	.0464Ddw + .0137Dw² + .0504dw + .0274Dw + .0169w	.4756Dw + .0441Dw² + .5132dw + 1.0478Dw + .0811w
5	.3333dw + .1406Dw + .1529w	0	.1864D	.0615Ddw + .0217Dw² + .0668dw + .0470Dw + .0252w	.5061Dw + .0544Dw² + .5417dw + 1.3080Dw + .0939w

Vousoir No. (1)	Sum of Horizontal Loads (14) = (16)	w′ (15)
1	.0062Ddw + .0001Dw² + .0088dw + .0001Dw + .0001w	
2	.0319Ddw + .0014Dw² + .0345dw + .0028Dw + .0018w	.0234Ddw + .0001Dw² + .0253Ddw + .0247Dw² + .0002Dw
3	.0688Ddw + .0036Dw² + .0745dw + .0146Dw² + .0079w	.0401Ddw + .0012Dw² + .0433Ddw + .0438Dw² + .0011Dw
4	.1162Ddw + .0196Dw² + .1249dw + .0430Dw² + .0238w	.0436Ddw + .0031Dw² + .0477Ddw + .0723Dw² + .0037Dw
5	.1667Ddw + .0413Dw² + .1807dw + .0800Dw² + .0488w	.0401Ddw + .0060Dw² + .0436Ddw + .0469Dw² + .0059Dw

Vousoir No. (1)	w″ (17)
1	
2	.0013Ddw + .0002Dw² + .0014Ddw + .0018Dw² + .0000Dw
3	.0052Ddw + .0008Dw² + .0101Ddw + .0144Dw² + .0005Dw
4	.0299Ddw + .0012Dw² + .0334Ddw + .0467Dw² + .0018Dw
5	.0483Ddw + .0045Dw² + .0483Ddw + .0961Dw² + .0045Dw

$\Sigma m = -.3458D^4dw + .0183D^3w + .3746Ddw + .5330Dw + .0188Dw$ $\qquad \Sigma my = -.1038D^4dw + .0054D^3w + .1122Ddw + .1590Dw + .0065Dw$

$$M_x = \frac{5(.1038D^4dw + .0054D^3w + .1122Ddw + .1590Dw + .0065Dw) - (.3458D^4dw + .0183Dw + .3746Ddw + .5330Dw).902D}{(.902D)^2 - 5(.2760)D^2}$$

$$M_z = Dw(.3601d + .0233D + .5604) + w(.3608d + .0275)$$

$$M_z = \frac{9020D(.1038D^4dw + .0054D^3w + .1122Ddw + .1590Dw + .0065Dw) - .2760D^2(.3458D^4dw + .0183Dw + .3746Ddw + .5330Dw)}{5(.2760D^2) - (.902D)^2}$$

$$M_x = D^2w(.0043d - .0012D + .0073) + Dw(.0044d + .0007)$$

Courtesy of Civil Engineering

Table for calculating stresses in a brick sewer.

The derivation of the formulas was based on the method for indeterminate structures.[L11]

Steel Sheeting Sewer Trenches

The Sup't. of Sewers of Louisville, Ky., G. R. Gregg, sheeted trenches with 14 ft. length of corrugated 8 gauge metal sheeting driven ahead of excavation in sandy-gravelly soil, using air hammers delivering five hundred 100-lb. blows a minute. Each unit was drawn and re-used at least 35 times, using a hand winch with hooks in two pulling holes for drawing. Ends of sheet piles that became battered were ground smooth with a portable emery wheel. The cost for 5,957 ft. of trench was less than with wood sheeting.[G33]

Unusual Sewage Plant Features

At Seaside, Oregon, sewage is brought to the plant in pipes most of which were of creosoted wood with copper bands; a river crossing being made with 8" pipe of this kind, double burlap-wrapped, suspended under the caps of the piling on which a street bridge is built. Cast iron pipe was used where there was little backfill and there was danger of wood pipe floating, and in the six pumping stations installed to minimize deep cutting on a long, flat outfall line.

These pumps operated intermittently, and should several happen to operate at once there would be a high rate of flow to the treatment plant. To keep the flow more nearly uniform, a tank with a hopper bottom was placed in the roof of the operating room to receive the sewage, from which it enters the plant through an orifice outlet in the hopper bottom.

The effluent discharges into a river up which incoming tides set strongly; therefore a retention basin is provided which stores the plant effluent during flood tide and releases it when the ebb flow is strong; the discharge being controlled by a time-switch-actuated hydraulically operated gate valve, the time switch being set daily on tide schedules to open and close the valve so as to provide two retention periods.[H55]

Vacuum Filtration In Three Cities

Experiences in three cities, Auburn, N. Y., Elmira, N. Y., and Greece, N. Y., have led each to these to change the sludge conditioning agent for vacuum filtration from anhydrous ferric chloride to liquid ferric chloride, obtained in 12-gallon carboys. Auburn originally dumped the anhydrous chloride into the sludge, but found this a highly dangerous and disagreeable task, while use of the solution was safer, quicker, more pleasant and also more economical, 12.5% less ferric chloride being used in the liquid form, since it mixes more readily with the sludge. Elmira found use of the anhydrous resulted in staining the walls and leaks from supply pipes and mixing tanks and splashing and destruction of the clothing of the operators. They also found economy in using the liquid material by applying it continuously to the sludge as it flows through the mixing chamber immediately before it reaches the filter tub instead of adding to the sludge in batch mixes. Greece began in 1938 dissolving a 150-pound drum of anhydrous material in a rubber lined tank of 48 gallons capacity, then drawing the solution by vacuum to a storage tank in the chemical room, then feeding by gravity to the feeders and the mixing tank. In dissolving the powder, the temperature of the solution reached 170° F and the high temperature softened the hard rubber pipe and feeders, causing leaks and warping. In May, 1940, change was made to the liquid ferric chloride, which is found easier to handle, cheaper and easier on the equipment and also more economical.

In Auburn the sewerage system is combined and contains much silt, little of which is removed by the grit chambers, and grit accumulates in the rapid-mix tanks and in the flocculation tanks and has to be scraped out at intervals. In

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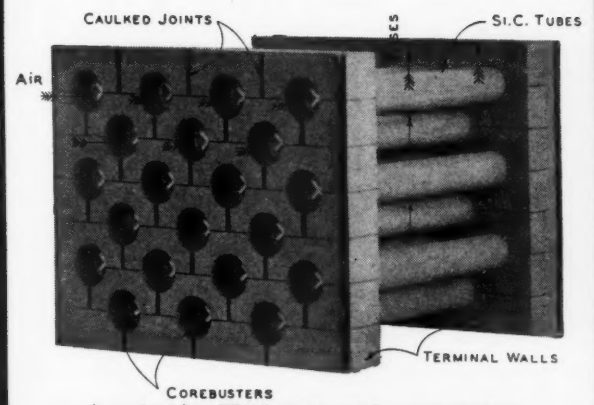

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winter the rapid mix and flocculation tanks are by-passed and the grit settles in the sedimentation tanks, packing around the sludge suction pipe and making it very difficult to pump out the sludge. The fine sand in the sludge rapidly clogs the filter cloths, and the sludge sloughs off the vacuum filter as it is being picked up and falls back into the tank. The variation in dose of the conditioning chemical according to per cent of solids is obtained by varying the quantity of sludge rather than of chemical.

Of the several types of cloth used on the filters, including glass cloth, No. 1 cotton has been found best at Auburn, a maximum run of 661 hours having been obtained. Greece has tried wool, cotton flannel and cotton without nap. The last was blinded within six hours; the wool cloth lasted 300 hours and the cotton flannel about 130 hours, but as the former cost six times as much as the latter, the cotton flannel is being used, although the wool lowers the moisture content of the filter cake 3 or 4% more than the cotton.

Instead of pumping the ferric chloride solution into the storage tank, which gives considerable trouble at times, Greece uses a tightly closed tank and raises the ferric chloride into it by producing a vacuum in the tank by means of the filter vacuum pump. Greece finds sludge mixing by paddle agitators revolving at 6 rpm to be far superior to mixing with three air diffuser tubes which was originally employed.[C 79]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n,* note or short article; *p,* paper before a society (complete or abstract); *t,* technical article.

E *Engineering News-Record*
November 21

31. World's Largest Sewage Disposal Plant Will Be Doubled in Size. (Chicago.) Pp. 68-69.

G *Water Works & Sewerage*
November

33. *c.* Corrugated Sheeting Used in Sewer Construction. P. 548.

H *Sewage Works Engineering*
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55. "Battleship" Sewage Plant by the Sea. (Seaside, Ore.) By R. E. Koon. Pp. 548-552.
56. Corrosion-Proof Station Pumps Flood Waters (at Schenectady, N. Y.). By E. G. Liberty. Pp. 553-555.
57. *p.* Sludge-Conditioning Chemicals. P. 555.
58. Refuse Incinerator at Schenectady, N. Y. By H. W. Taylor. Pp. 556-557.
59. Guggenheim Process Operation at New Britain. Pp. 564-565.

J *American City*
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25. Sewage Treatment at Bedford, O. By A. H. Wedge. Pp. 47-49.
26. New Sewage Treatment Plants for Springfield, Mass. By A. A. Burger. Pp. 66-67.

K *Proceedings, Am. Soc. of Civil Engineers*
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1. Reliability of Station-Year Rainfall-Frequency Determinations. By K. C. Hapstad. Pp. 1603-1622.

L *Civil Engineering*
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9. Sixty-Year Rainfall Record Analyzed. By H. F. Kennison. Pp. 709-710.
10. Storage Basins as a Supplement to Storm Sewer Capacity. By J. A. Rousculp. Pp. 715-718.
11. Simplified Stress Analysis of Three-Ring Sewers. By G. I. Sawyer. Pp. 720-722.

M *Canadian Engineer*
October

8. *p.* Trends and Newer Features in Sewage Treatment. By S. A. Greeley. Pp. 41-44, 65.
9. *p.* Treatment and Control of Industrial Wastes. By M. P. Adams. Pp. 50-65.

P *Public Works*
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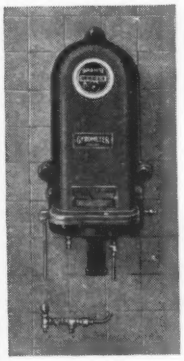
56. Cooperation and Organization Help in Sewer Construction. By R. M. Lingo. Pp. 16-18.
57. Refuse Disposal for Airports. By A. E. Stilson. Pp. 23-24.
58. Sewage Disposal for Airports. Pp. 25-26, 38.
59. Municipal Improvements at Morganton, N. C. By C. F. Lewis. Pp. 36-38.

Overflow of Leach Basin For Jury

The New Jersey Court of Errors and Appeals holds, Rooney v. Millstone Tp., 121 N. J. L. 624, 3 Att. 2d 580, that a municipality has no right, by artificial drains, to divert surface water from the course it would otherwise take and cast it in a body large enough to do substantial injury on land where, but for such artificial drains, it would not go. Whether a township, in connecting four catch basins with a leach basin it built upon plaintiff's property with his permission while improving a road was guilty of active wrongdoing because the leach basin from time to time overflowed was held a jury question.



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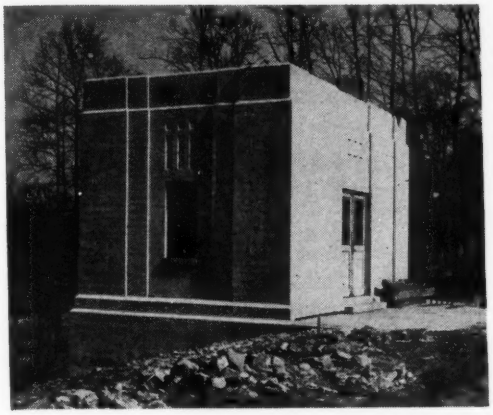


Gate house at sedimentation tank of Ashland, Ky., waterworks.

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Making a Reservoir Tight

Tucson, Ariz., recently constructed a covered reservoir of 7.33 mg capacity, using gunite slabs with "Thermoplastic rubber" joints for the floor. The proportion of rubber to coal tar in the joint material was important in securing a material that would flow under pressure. About 350° was found to be the maximum safe heating temperature; pouring methods had to be devised to eliminate steam or gas bubbles from the finished work, and four trials were required to get satisfactory results. Leakage was 1,100 gpd as determined by use of evaporation gauge and hook gauge. Some defective gunite was located and repaired by the contractor, and bentonite also was used, and one month later the leakage was only 100 gpd and at present no loss can be detected.[G 44]

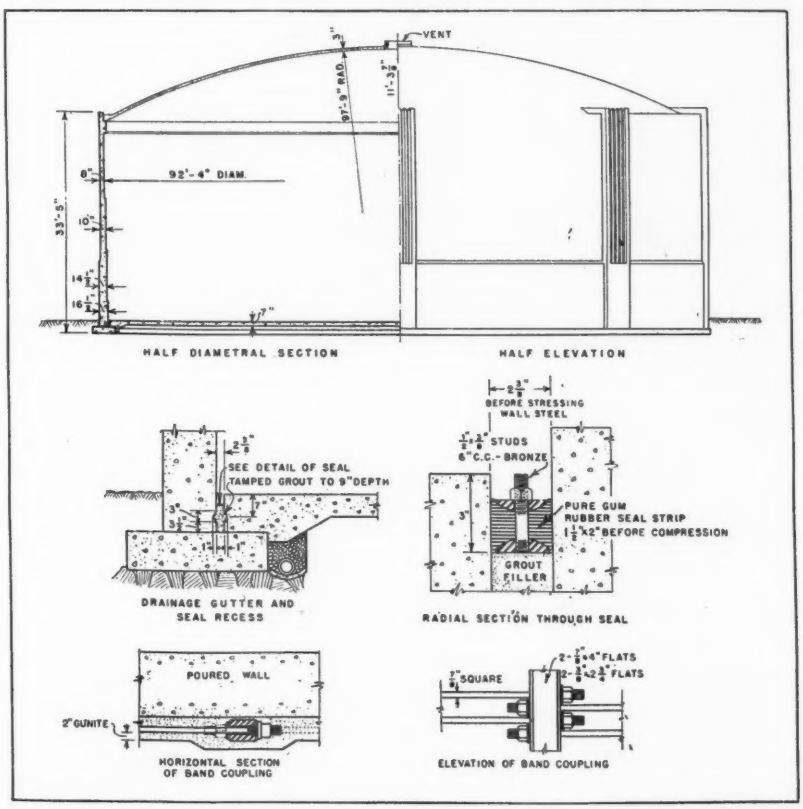
Reservoirs in East Bay District

Owing to great irregularity of topagraphy in the area east of San Francisco Bay, the water service of the district is divided into 67 distribution zones served by 41 pumping plants, each with a reservoir. Also in the past 11 years 51 wood or steel tanks and 10 pre-stressed concrete reservoirs have been built; the latter and concrete-lined earth reservoirs in residential zones for appearance, steel tanks in industrial sections. Steel tanks are made with concrete bottoms, into which the steel tank wall is set about 6″; this construction being safer against earthquakes than steel bottoms, eliminating bottom corrosion and saving cost of painting.

In designing capacity for a given district, the probable consumption is estimated by the "depth-over-area" method, the estimated consumption per year being expressed in terms of feet depth over the area in question. This depth varies with the character of the district but was found to be quite uniform for each character. Ratings determined by meter readings vary from 1.1 to 2.0 ft. in residential sections; in commercial districts from 1.0 to 6.0 ft., depending on class and height of buildings. The method is not applicable to the widely varying conditions of industrial districts.[A 170]

Pre-Stressed Concrete Reservoirs

Most of the new storage structures built in residential sections of California's East Bay Municipal Utility District are of pre-stressed concrete—one 3,500,000 gal. capacity. The circumferential edge of a reinforced concrete bottom slab rests on an annular concrete base, which also supports the concrete wall, a 2⅜″ space separating wall and bottom slab. After the wall has been completed, this annular slot is sealed by inserting in it a pure rubber strip of rectangular section 1½″ x 2″, compressed between two half-oval steel strips, top and bottom, by means of ½″ bronze studs spaced 6″ centers. The side wall is poured as a number of vertical units, the edge of each painted with a 1:3 mixture of iron dust and cement before the next is poured. Then vertical steel box-type beams are set at approximately 40 ft. intervals around the structure and tied together with ⅞″ square reinforcement rods that pass through holes in



Courtesy American Water Works Ass'n

Detail of reinforcement on prestressed concrete reservoir.

the beams, and then all the rods are drawn up by nuts to the desired stress, which is such that it will be 30,000 lb. per sq. in. when the tank is full of water. The maximum concrete stress when the reservoir is empty is 500 lb. per sq. in. Wire mesh reinforcement is then placed around the tank and the whole is coated with gunite to a thickness of ¾" over the steel. In some cases a second layer of reinforcing rods and gunite is applied over the first. For reservoirs up to 93 ft. diameter, dome-shaped roofs are used; for larger ones, slab roofs with square supporting columns. These reservoirs are bottle tight.[A 170]

Protecting Pipe From Freezing

Portland, Me., has not found insulation of water services to satisfactorily prevent freezing, except rubber insulation on copper services. But a board laid on top of a service only 2½ ft. deep prevents freezing. "The board seems to divide the frost when it strikes and the frost goes down on either side." A 6" pipe which carries a supply 2,000 and 3,000 ft. under salt water to an island is prevented from freezing by heating the water with an electric heater in a pit before the pipe enters the water.[V9]

Concrete Coating For Cast Iron Pipe

In Everglades, Fla., the muck soil is so high in corrosive acids that cast iron pipe in the distribution system had a life of only 7 or 8 years, and the entire system began leaking through pit holes. To remedy this and prevent future corrosion, all the mains were covered in place with 1" thickness of mortar made of 1 part portland modified cement containing less than 8% tricalcium aluminate (a type used in Boulder dam) to 2½ to 4 parts of clean, fine sand. After 6 yrs. of service, this mortar shows no sign of leaching, it not only protects the pipe but stops leaking through existing holes although pressures of 60 to 70 lb. have been maintained. In placing the mortar, trenches were dug down to the pipe, it was suspended from timbers, the soil removed from all around it and the pipe thoroughly scraped and wire-brushed, and forms of galvanized sheet iron suspended around the pipe, and filled with mortar of a consistency that would flow readily. Next day the forms were removed, any flaws remedied and the trench flooded with water; next day they were backfilled to the top of the pipe and thoroughly tamped and backfilling completed. The American Cast Iron Pipe Co. has developed a factory-applied cement coating which the author was unable to crack or flake by pounding with a heavy hammer.[A 164]

Butane for Internal Combustion Engines

For small pumping plants or those some distance from town driven by internal combustion engines, the use of liquified petroleum gases such as butane for fuel is coming into extensive use in the oil fields, where its cost is 6 or 7 cts. a gal., and to a less extent elsewhere. It contains about 3,300 B.t.u. per cu. ft. It is available either in high-pressure cylinders or by tank truck delivery into low-pressure storage tanks.[A 161]

Life of Coal-Tar Enamels

In investigating the service life of coal-tar enamel coatings on steel water pipe in Los Angeles, abrasion tests were made and original coal tar enamels showed 15 times as much loss by abrasion as improved type coal-tar pitch enamels having a penetration of 10 at 77°F; spun cement mortar lost 3 times as much by abrasion, hand-tamped concrete 5 times, asphalt mastic 7 times. Even the original type, how-

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ever has a record of 46 yrs. of continuous use on steel pipe in Los Angeles, with many more years additional life remaining. The improved coal-tar pitch enamels equal this in resistance to deterioration from water penetration, and are greatly superior to it in physical and performance characteristics and can withstand considerable abuse.[A 163]

Softening Plants Of Special Interest

Softening plants designed to meet certain specific problems include: Topeka, very turbid water. Oklahoma City, under-water burner for recarbonation, and merging sludge with slurry. Springfield and Woodstock, Ill., Spaulding precipitators. Williams Bay, Wis., using sludge blanket operating differently from the Spaulding precipitator, and plant entirely automatic. Greendale, Wis., automatically controlled zeolite plant. La Grange, Ill., combined lime and zeolite softening. Consolidated Edison in New York City, carbonaceous zeolite on the sodium and hydrogen cycles for boiler feed water. Chemical laboratory at Texas Technological College, where Dr. Goodwin is experimenting on removal of fluorine from water.[G 45]

A Portable Purification Plant

When the water plant of Weldon, N. C., was flooded last August, a temporary supply was furnished by a portable plant developed for use by the Army which was rushed to the town and pumped and purified 110,000 gpd. It consists of a gasoline engine-driven pump, hypochlorinator, two chemical feeders, hypochlorite solution reservoir, and a complete filter unit containing 4″ of quartz sand on 18″ of gravel. The unit carries three qualified operators and has a capacity up to 180,000 gpd, depending on the amount of treatment needed.[E42]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

E *Engineering News-Record*
November 21

41. Reservoirs and Dams, Delaware Water Supply System. Pp. 58-62.
42. Portable Purification Plant. By D. W. Gillette. Pp. 66-67.
43. *t.* Loss-of-Head Determination in Uniformly Tapped Pipes. By R. D. Gladding. P. 67.
44. Water for a Desert Town. By H. T. Bruce. Pp. 73-74.

F *Water Works Engineering*
November 6

96. Thawing Frozen Water Lines. Pp. 1396-1398.
97. *p.* Filter Operation and Maintenance. By J. R. Baylis. Pp. 1402-1404, 1432.
98. Operation and Maintenance: Elevated Storage. Pp. 1421-1422.

November 20

99. What To Do With Lime Sludge. By H. V. Pedersen. Pp. 1456-1457.
100. Filter Operation and Maintenance. By J. R. Baylis. Pp. 1460-1462, 1483.
101. Operation and Maintenance: Elevated Storage. Pp. 1473-1474.
102. Fires in Meter Boxes Do Damage. P. 1476.

G *Water Works & Sewerage*
November

44. Tucson's Water Works Improvements. By J. A. Carollo and P. J. Martin, Jr. Pp. 505-508.
45. Amercian Water Softening Plants of Especial Interest. By L. J. Alexander. Pp. 520-525.

J *American City*
November

35. Treating Water of High Color. (At New Canaan, Conn.) Pp. 60-62.

K *Proceedings, Am. Soc. of Civil Engineers*
November

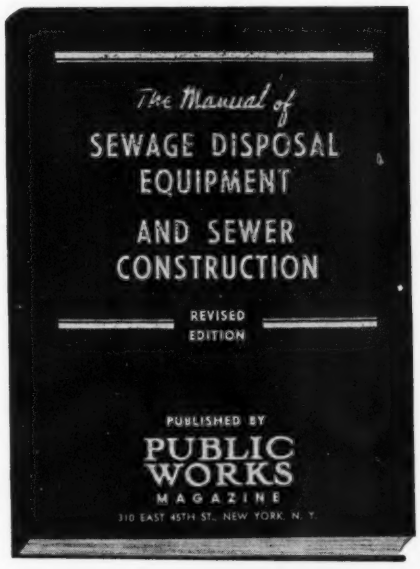
4. Cavitation in Outlet Conduits of High Dams. By H. A. Thomas and E. P. Schuleen. Pp. 1623-1658.

P *Public Works*
November

41. Measures and Procedures to Prevent Sabotage of Water and Sewage Plants. By M. J. Blew. P. 22.
42. Water Supply and Sewage Disposal for Airports. Pp. 25-26-, 38-39.
43. Water Supply for the Army. Pp. 28-30, 43.
44. Municipal Improvements in Morganton, N. C. By C. F. Lewis. Pp. 36-38.

V *Journal, Maine Water Utilities Ass'n.*
November

8. Effect of Ammonia-Chlorine Treatment on Water Mains. By H. B. Scales. Pp. 146-151.
9. Protecting Water Pipes From Frost. By F. J. Rent. Pp. 154-160.



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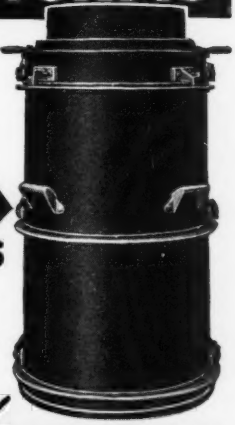

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A high tonnage capacity is due to the one-pass cutting principle. The anvil

Diamond Roller-Bearing Hog.

knives are so located and adjusted that material must be reduced to pass; therefore, there is no screen in the bottom of the mill and no rotation of the product within the mill. The knives are ground at a slight angle similar to those of the heavy-duty metal shears, assuring ruggedness and long service.

Write Diamond Iron Works, Inc., Minneapolis, Minn., for complete information.

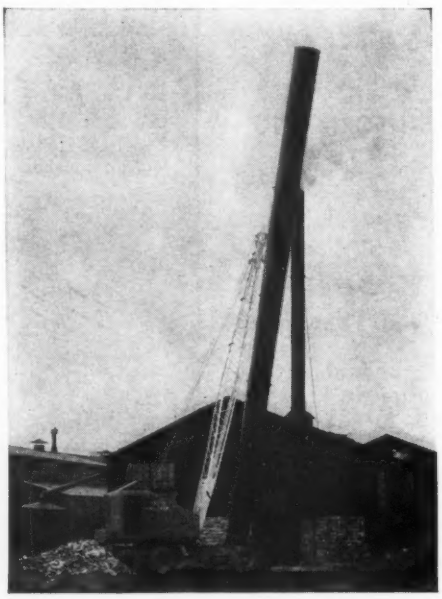
Mobil-Crane Announcement

The Osgood Company, Marion, Ohio, announces its new Mobil-Crane, a one-man, one motor, pneumatic-tired machine which is a new idea in material handling equipment. In developing this, The Osgood Company believes that they have made a definite contribution to the demand of modern industry for greater speed and mobility in material handling machinery. No tracks or special preparation are required to move the machine. It will travel in a storage yard wherever an industrial truck will go. The Mobil-Crane was named for its mobility; it has four speeds, forward and backward, and will lift and carry loads up to 15 tons, and swing its load in a full circle. Speeds up to 5 miles per hour with load can be obtained.

The Mobil-Crane pictured here is setting an 80 ft. 9,500 lb. stack, an operation requiring precise control, and reserve strength and power. Booms of 45, 50, and 55 ft. are standard; longer booms can be furnished for special requirement. It can be equipped to load and unload any kind of material, with hook, sling, magnet, or clamshell bucket.

Steering is accomplished by hydraulic control, and the machine may be turned in a 50 ft. radius. Front and rear wheels are equipped with air brakes of the internal expanding type, affording maximum safety when travelling on the highway.

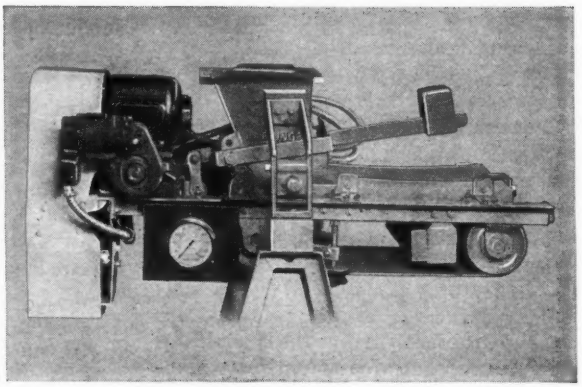
For additional information and specifications, write this publication or The Osgood Company, Marin, Ohio.



Osgood "Mobil-Crane".

Hardinge Weight Recording Feeder

Hardinge Company, Incorporated, of York, Pennsylvania, announces a new weighing feeder, which incorporates a direct recording and totalizing attachment. Like the Hardinge Constant Weight Feeder, this new feeder uses the principle of a compensating balanced belt on a pivoted frame, which has proven to be extremely accurate, but very simple. In the present design the feeder is calibrated to read direct in either tons, pounds or kilograms, which reading is registered by a pointer on a meter. On this same meter are two weight-recording registers, one of which records the total accumulated weight, and the other is a reset register which records batch or time runs. The same system may be employed for use when the feeder is controlled remotely, and the recording instruments may be placed on a panel any distance desired from the location of the feeder. The simplicity and accuracy of this device are particularly advantageous in more or less cramped and dusty locations where close control and accuracy are required. The feed rates of various sizes of these feeders range from 2 or 3 pounds to 2,000 tons per hour. The size of feed ranges from fine products up to pieces as large as 12" diameter.



Hardinge's Recording Weighing Feeder.

Expansion Jointing Compound

Under the trade name of Rai-Seal, Rubber Associates, Inc., Rockefeller Center, New York, N. Y., is producing a hot-poured rubber compound for sealing expansion joints in concrete pavements and structures. It is claimed that this product provides a continuous and positive seal for the expansion joint section against the infiltration of water at all ranges of temperature. It is applied in the same manner as bituminous seals and no priming of the concrete or preparation other than having a clean dry surface is necessary. And it is claimed that Rai-Seal solidifies rapidly and is ready for traffic within twenty minutes and is free from bleeding.

The manufacturer will be glad to supply further detailed information and specifications for its use.

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PERSONAL NEWS

The following new appointments as city engineers have been reported:

W. H. Davis, Antioch, Calif.
Elmer Fillebrandt, Winthrop, Minn.
Bernal Swab, Altoona, Pa.
E. J. Althul, Union, S. C.
Willard Wristen, Chamberlain, S. D.
C. Luckett Watkins, Alexandria, Va.
Gordon B. Fox, Puyallup, Wash.

The following new appointments as county engineers have been reported:

B. E. Roberts, Troup County, La Grange, Ga.
R. F. Mitchell, Power County, American Falls, Idaho.
Wilbur A. Racely, Thurston County, Pender, Nebr.

The following new appointments as water works superintendents have been reported:

W. Richard Geiston, Jr., Quincy, Ill.
Glen Wilson, Bastrop, La.
Geo. McKenzie, Alpena, Mich.
Geo. Dienst, Owatonna, Minn.
Edward Myers, Maryville, Mo.
D. W. DeWitt, Walton, N. Y.
H. C. Growdon, Portsmouth, Ohio.
C. C. Brown, Del Rio, Tex.

Dr. Hamilton Gray has been appointed by New York University, N. Y., to establish and direct a new laboratory for the study of foundation soils and soil mechanics. Dr. Clair N. Sawyer has been appointed assistant professor of sanitary engineering.

M. R. Keefe, Chief Engineer for the State Highway Commission of Indiana, has resigned to accept another position and Earl B. Lockridge succeeds him as Acting Chief Engineer.

Commissioner Studebaker Appoints Advisory Committee on Engineering Defense Training

Appointment of an Advisory Committee to the U. S. Office of Education on Engineering Training for National Defense was announced today by John W. Studebaker, U. S. Commissioner of Education.

Members of this Committee, who represent leading engineering schools and colleges and who will advise the U. S. Office of Education on matters of policy affecting the national defense training program in engineering schools are:

Andrey A. Potter, Dean of Engineering, Purdue University (Chairman).

R. E. Doherty, President, Carnegie Institute of Technology.

Gibb Gilchrist, Dean of Engineering, A. and M. College of Texas.

H. P. Hammond, Dean of Engineering, Pennsylvania State College.

W. O. Hotchkiss, President Rensselaer Polytechnic Institute.

R. S. McBride, Consulting Engineer, Washington, D. C.

Thorndike Saville, Dean of Engineering, New York University.

C. C. Williams, President, Lehigh University.

B. M. Woods, Chairman, Department of Mechanical Engineering, University of California.

Allen W. Horton, Jr., U. S. Office of Education (Secretary).

Water and Sewage Problems Studied by Army Officials

The War Department has secured the service of Metcalf & Eddy, Boston, Mass., and Greeley & Hansen, Chicago. These engineers are soon to prepare a report and make recommendations on the most appropriate methods of Sewage Treatment at new cantonments and existing camps being enlarged.

Death of Chas. L. Allen

Chas. L. Allen, for many years president of the Norton Company, died on November 4 at his home in Worcester, Mass., of bronchial pneumonia. He was 82 years old and had been general manager of the Norton Company for 48 years until his retirement in 1933. He was largely responsible for building up the Norton Company from a small pottery shop to the prominent position it now holds as a manufacturer of abrasives and of diffusers for activated sludge plants. He occupied an important position in the business and social life of Worcester; was one of the founders of the Merchants National Bank and a life member of the board of trustees of Worcester Polytechnic Institute. He was director of several companies and member of a number of business and tecnical organizations and of several municipal commissions. He leaves a daughter, a sister and a brother.

Joe J. Pitt, Pittsburgh Equitable Meter Salesman, Dies

Joe J. Pitt, West Texas Representative for the Pittsburgh Equitable Meter Company, died suddenly in Fort Worth on Nov. 14th as the result of a heart

Jos. J. Pitt.

attack. He was 47 years old. The body was placed in the Mission Cemetery in San Antonio. Surviving is a 16 year old son.

Mr. Pitt was born in Val Alstyne, Texas. In the World War, he served in the Marine Corps. He was engaged in the hardware and equipment business until 1930 when he became Texas representative for the National Meter Company. In September, 1939, he joined the sales staff of the Pittsburgh Equitable Meter Company.

A seasoned salesman, he was well known throughout the Southwest by all Water Works men. Joe Pitt was possessed of a fine personality. His passing will be keenly felt by all with whom he was associated.

Death of William M. Rapp

On November 19 William M. Rapp, Sr., Superintendent of Construction and Distribution of the Atlanta Water Works, died at his home after a lingering illness. He was 69 years old and had been employed in the Water Department for 55 years. It is believed that this length of service is a record, probably most nearly approached by the water department's General Manager W. Zode Smith, who has been 50 years in the city's employ. Mr. Smith says of Mr. Rapp that he was a practical man, devoted to his work, and with great ingenuity, having saved the city thousands of dollars through his inventions, among which were the Rapp screw plug and Rapp tapping machine. He was an honorary life member of the American Water Works Association, one of the organizers of the Georgia Water and Sewage Operators School, and a 32nd Degree Mason.

Annual Meeting of National Paving Brick Association

The thirty-fifth annual meeting of the National Paving Brick Association will be held in Toledo, Ohio, January 15, 16, and 17, 1941, at the Commodore Perry Hotel. Those interested in modern brick pavements and street and highway development are cordially invited to attend.

The program will include papers and disussions by prominent engineers, contractors and research men on recent developments in manufactuing, experience in research and testing, and in construction methods. Among the subjects to be discussed are the vibrated monolithic pavement, the modern two-course pavement, and additional experience with reinforced slabs.

The relationship of the modern brick pavement to the highway problem of the present and future will be an important theme of the convention. This will emphasize the contribution that brick makes to highway safety and its adaptability for heavy duty pavements in metropolitan areas.

C. C. Blair, head of the Metropolitan Paving Brick Company of Canton, Ohio, is President and William H. Cullimore is Chief Engineer and Secretary of the National Paving Brick Association, National Press Building, Washington, D. C.

In this issue:
WATER AND SEWAGE CHEMISTRY AND CHEMICALS

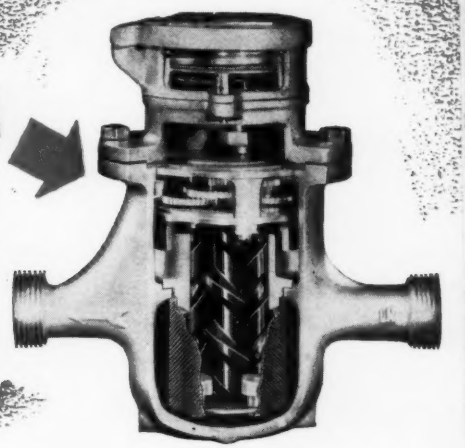
DECEMBER, 1940

PUBLIC WORKS

Engineering Library
DEC 3 1940

Streets and Highways • • • Water Works
Sewage Disposal

QUIET
IS REQUESTED FOR THE BENEFIT
OF THOSE WHO HAVE RETIRED



Stop nerve racking meter noise forever!..

INSTALL PITTSBURGH IMO WATER METERS

LITTLE annoyances often become major nuisances. In the category of nuisances is the persistent clicking sound so frequently resulting from the operation of conventional meters. Do you make your consumers tolerate such nerve racking disturbances?

Meter noise varies in intensity with the length of service. A worn meter, especially one installed in certain types of frame dwellings, can produce sounds which will be telegraphed and amplified throughout the entire structure. These sounds are particularly annoying at night to those who have retired. The use of flexible copper tubing also tends to accentuate the transmission of meter noise.

The IMO meter runs "as quiet as a mouse." Due to its basic construction, it will never become noisy. The IMO operates silently, both when new and after millions of gallons have been measured. The use of *revolving parts*, rather than nutating or oscillating parts, results in a smoothness and quietness of operation that sets a new standard for domestic meter performance.

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MERCO NORDSTROM VALVE CO.
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You are invited to test the IMO meter on your own lines.
Ask for demonstration or write for a copy of Bulletin W-529.

Remember—PITTSBURGH IMO METERS WEAR IN WHERE OTHERS WEAR OUT

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GIVE YOU

BOARDS OF HEALTH AND CONSULTING ENGINEERS

OPERATORS OF WATER AND SEWAGE PLANTS, DAIRIES, CANNERIES, BOTTLERS AND OTHERS

OPERATORS OF SWIMMING AND WADING POOLS

Merry Christmas

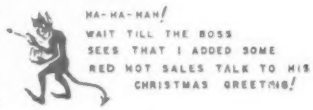
AND A HAPPY NEW YEAR

We, at

CHEMICAL FEEDER HEADQUARTERS

are grateful to all of you who have cooperated (even more than Santa Claus) toward our eighth year of continued growth by keeping us and our factory busier than ever.

Our good customers have taught us that machines are made of materials plus brains and the more brains, the less materials required. This accounts for the HEADstrong appearance of our guiding spirit pictured here. You will note, he is also a HANDy fellow.



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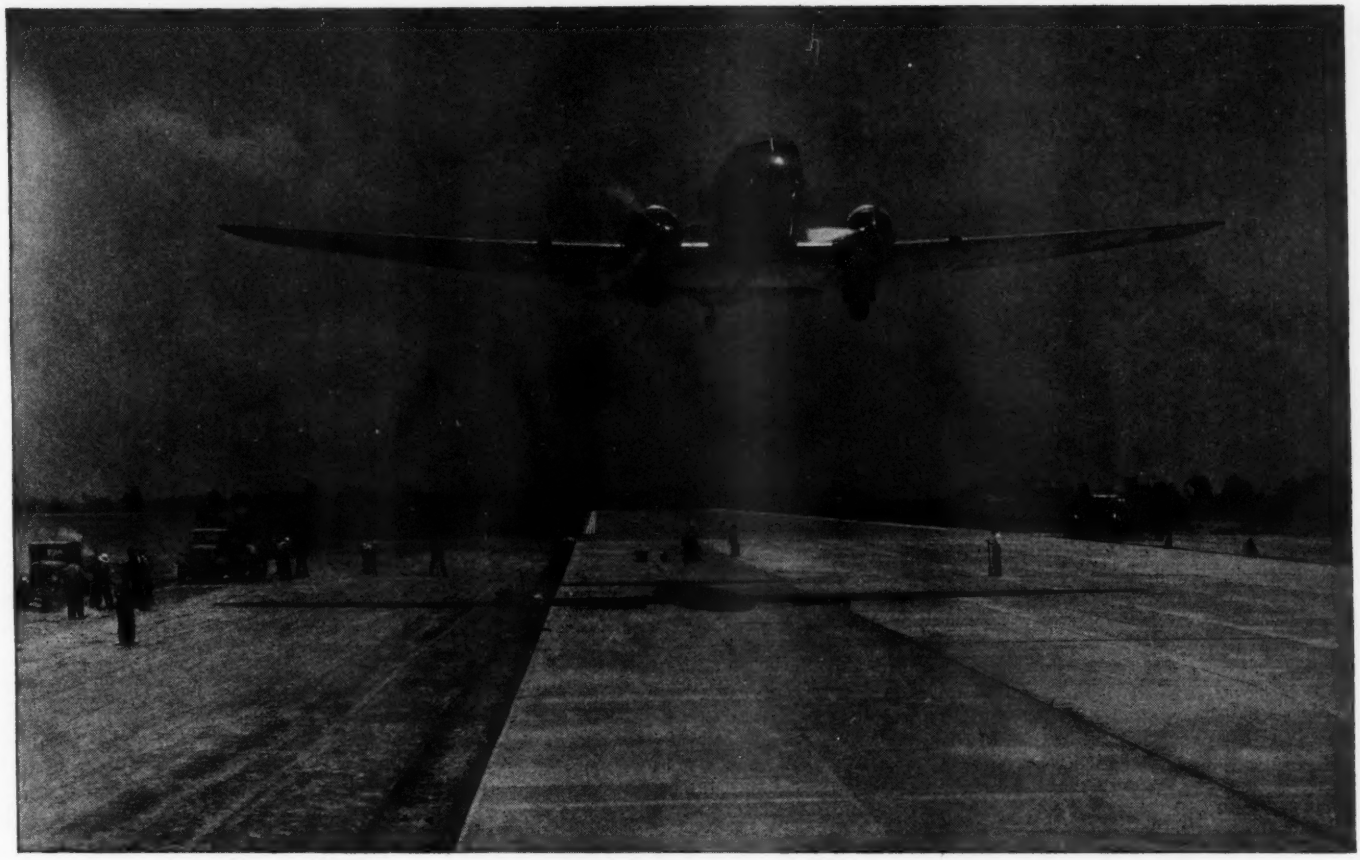

SPEED DEFENSE CONSTRUCTION

SAVE VITAL WEEKS THIS WINTER WITH 'INCOR' 24-HOUR CEMENT

MAKE every day count this winter . . . avoid the usual cold-weather slow-down . . . push construction ahead on normal schedules, even in sub-freezing weather. Save time, and money, by using 'Incor' 24-Hour Cement.

Faster Speed, Lower Cost

'Incor', the improved Portland cement, hardens in one-third the usual time. Concrete is safe from freezing, ready to use, that much sooner. Heat-protection costs are 50 to 60 percent lower. Form costs are reduced. Earlier completion cuts overhead or time costs.

'Incor' makes better concrete, too—by curing thoroughly in a fraction of the usual time.

New factories and plant additions, highways, bridges and air-bases—large-scale projects like Indianapolis' Municipal Airport (above), where 80,000 sq. yd. of concrete were used in runways, taxi strips, aprons and driveways —can be pushed straight through the cold-weather months, without the usual costly winter delays, by using 'Incor' 24-Hour Cement.

Change to 'Incor'—Now

Speed defense construction . . . save vital weeks this winter . . . cut cold-weather costs—by changing to 'Incor'* now. 'Incor' is a cold-weather safety factor, proved by over 13 years' performance.

Write for copy of illustrated book, entitled "Cold-Weather Concreting." Lone Star Cement Corporation, Room 2203, 342 Madison Ave., New York. *Reg. U. S. Pat. Off.

LONE STAR CEMENT CORPORATION

MAKERS OF LONE STAR CEMENT · · · 'INCOR' 24-HOUR CEMENT

VOL. 71 PUBLIC WORKS No. 12
Entered as second-class matter at the Post Office at New York, N. Y., Sept. 1, 1922, under the act of March 2, 1879
Published Monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th Street, New York, N. Y.
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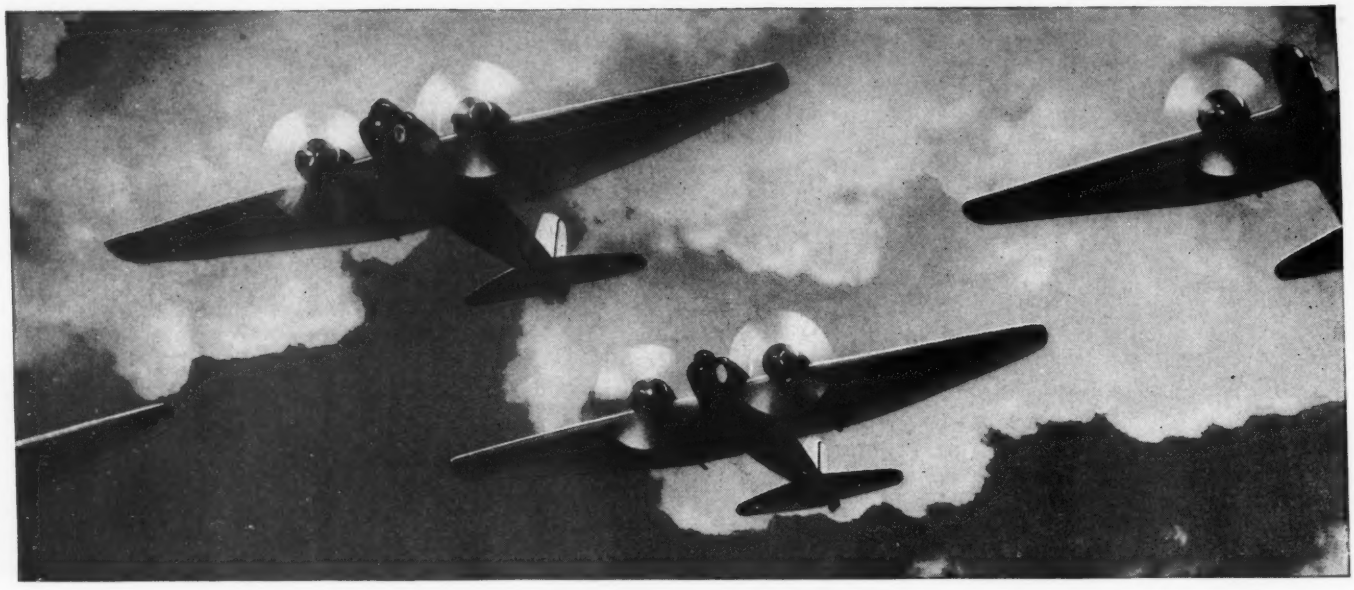
DECEMBER, 1940



IF YOU *Believe In Preparedness*

—Remember that water has always been, is now, and forever will be one of your most vital needs. It is an absolute necessity for MEN, MACHINERY and MATERIALS. Your present water supply may not be adequate for expansion—or emergency. It may be costing you too much. It may need enlarging.

Now is the time to practice preparedness. Without delay you may secure the cooperation of Layne Engineers who will check your present water supply and offer valuable recommendations on increasing volume or the lowering of operation cost. Behind these Engineers stand the world's foremost water developers; an organization equipped and capable of making dependable preliminary investigations, reconditioning old wells, drilling new ones, furnishing and setting pumps for a complete Well Water Supply System.

If you want facts about Layne Well Water Supply Systems, Layne Vertical Turbine Pumps, etc., with views and details about worldwide installations, write for illustrated literature. Address,

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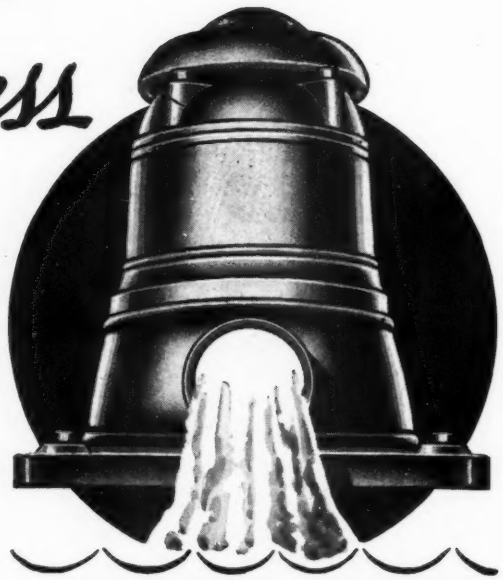

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INTERNATIONAL

"Auger Action"

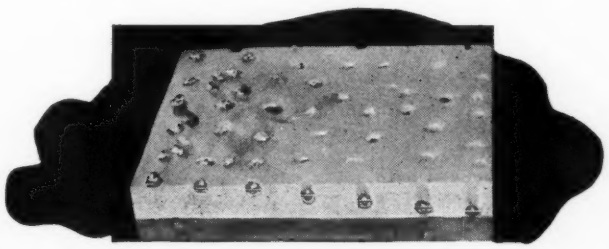
ROCK SALT

How it helps in keeping roads and streets clear of ice and snow in winter—at utmost low cost!

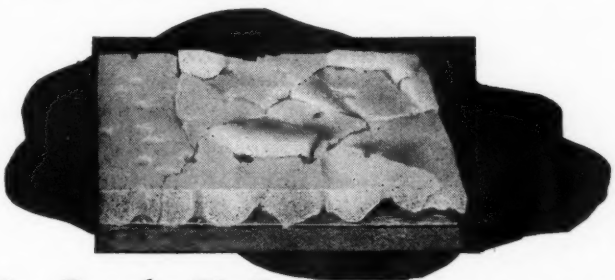
BELOW is a photographic reproduction of an accurate model showing Rock Salt's "Auger Action." This shows how Rock Salt works to *remove* hardpacked snow or ice. Many street and road officials have known of Rock Salt's powerful ice melting power for years. They have used Rock Salt with abrasives—and have seen how the Rock Salt melts snow and ice to help in its removal.

Today, an increasing number of street and road officials use International's Rock Salt straight, without abrasives, to keep city streets and long stretches of open highway, free and clear of ice and hardpacked snow all winter long. It is simple and easy. Rock Salt is spread at the *start* of a storm. Often this is enough to melt away all snow. In every case, it prevents the snow from packing, from forming ice and bonding to the pavement. If ice has formed, Rock Salt's "Auger Action" quickly bores through and undercuts it so that it can easily be scraped aside, plowed away or removed.

City and road officials alike now know that this method of using "Auger Action" Rock Salt straight provides a far higher degree of safety at a far lower cost. It reduces the number of men required. It saves in the cost of machinery. It is the one ice melting agent practical for complete snow and ice removal, because Rock Salt will melt two to three times as much ice per dollar, as any other available ice melting agent. For information about this proven, effective way of keeping streets and roads clear for utmost traffic safety, write for the folder, "Rock Salt's Auger Action."



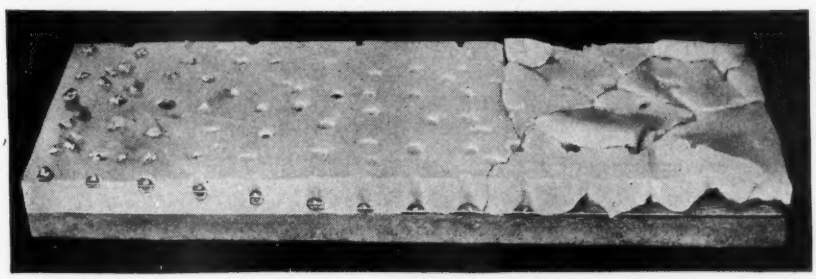
"Anti-skid" **Rock Salt crystals are an abrasive themselves. Spread on hardpacked snow or ice, International's "Auger Action" Rock Salt imbeds itself at once, to provide an "anti-skid" surface immediately.**



"Ice Breaks Up" **Ice when riddled with holes and undercut, soon breaks up. Any passing traffic speeds up the breaking process. Small bits of ice, loosened from the pavement, can be easily scraped aside, plowed away, or removed to leave the pavement completely bare and really safe.**

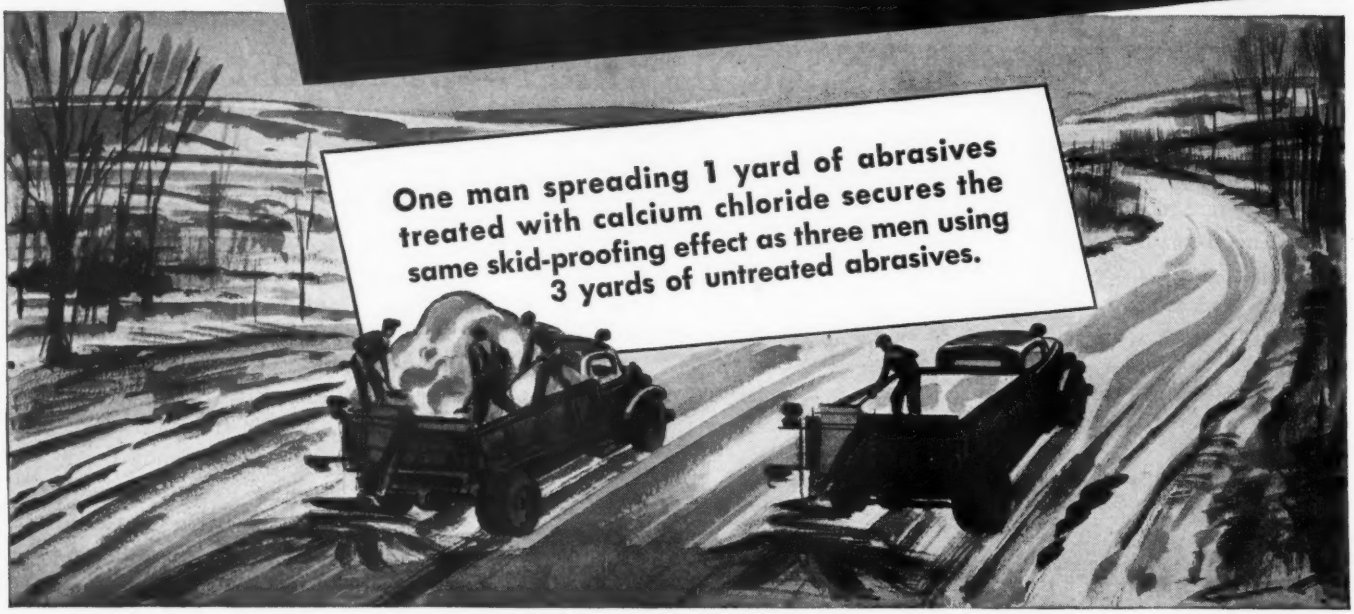
"Auger Action" **Crystals of Rock Salt bore through the icy covering as a carpenter's auger bores through wood. As it melts through the ice, brine is formed which undercuts the ice and loosens its bond with the pavement.**

INTERNATIONAL SALT COMPANY
INCORPORATED
Scranton, Pennsylvania



More proof that abrasives treated with Calcium Chloride

Go Farther-Work Faster-Cost Less


One man spreading 1 yard of abrasives treated with calcium chloride secures the same skid-proofing effect as three men using 3 yards of untreated abrasives.

Actual tests of unquestioned authority by state highway departments and engineering experiment stations show:

1. Skid resistance of ½ lb. of calcium chloride treated abrasives is greater than 1½ lbs. of the same abrasives untreated. Thus, you can save 2/3 of your abrasives and at least $6.60 per mile of 18-foot road by treating your abrasives with calcium chloride (at the conservative abrasive cost of $1.50 per ton applied).

2. One cubic yard of treated abrasives will go three times as far—saves loading 2 out of 3 trucks when in a hurry.

3. Abrasives treated with calcium chloride bite right into the ice and give traction, while untreated abrasives are brushed away by tires and blown off by high winds.

4. Calcium chloride treatment prevents freezing of stockpiles, which are thus ready for easy loading and uniform spreading, impossible with frozen lumps.

This Standard Calcium Chloride Treatment Saves Money—Speeds Work—Promotes Safety

Stockpile treatment with flake calcium chloride (at a rate of 50 to 75 lbs. per cubic yard of abrasives) is standard practice in practically all states faced with the problem of skid-proofing icy pavements.

ICE CONTROL SUGGESTIONS FREE

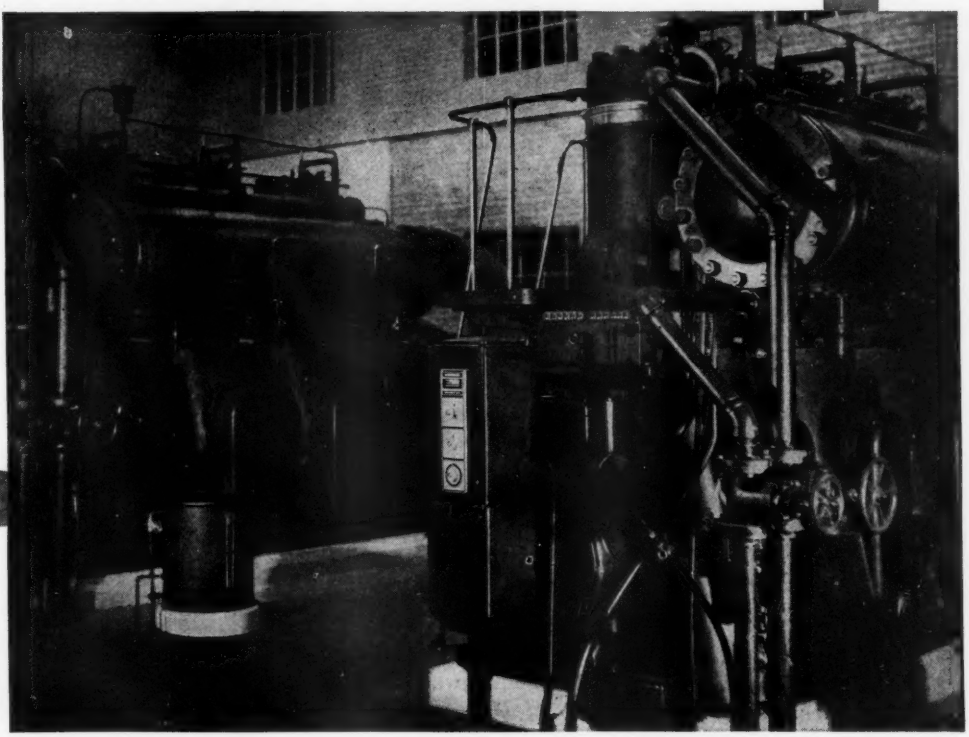
Write for recommended practices and for data on field tests made by states, cities and experiment stations—but more important get calcium chloride into all your stockpiles now. Save 2/3 of your grits—save 2/3 of your loading—save picking away at frozen piles—save frostbitten fingers. Get speed into your safety work when ice starts to form, before wrecks occur, by treating all abrasives with calcium chloride.

CALCIUM CHLORIDE ASSOCIATION
4145 PENOBSCOT BUILDING • DETROIT, MICH.

F-M DIESEL DIVIDENDS

No Increase in Taxes for This Texas Town!

MUNICIPALLY OWNED LIGHT PLANT PAYS CROSBYTON A HANDSOME NET PROFIT



Three F-M Diesels Pay Dividends to Crosbyton
Two of them are brand-new 225-h.p. engines, and the third is the old 120-h.p. F-M Diesel that served the city's ice plant for many years. All three are direct connected to F-M Alternators. All are slow-speed, two-cycle, heavy-duty Diesels which Fairbanks-Morse recommends for hard jobs of work. Operating cost records prove the soundness of this recommendation.

With the installation of two new Fairbanks-Morse Diesels, the Crosbyton, Texas municipal light plant went into operation about the first of this year with 60% of the town's business. It was then estimated that profits from the plant would net the citizens of Crosbyton $6800. After thirty days of operation, however, business increased to 74% of the potential—and will probably go to 80%. That will bring net profits up to $11,400 for Crosbyton. In addition, the plant furnishes free street lighting, eliminates an annual bill of $915 for purchased power—all *without any increase whatever in taxation.*

Municipal benefits without increased taxation, lower taxes, free street lights, free fire fighting equipment, park and street improvement, etc. are the *usual* results of municipally owned light plants powered with F-M Diesels. The lower operating and lower maintenance cost of F-M Diesels makes a big difference in earnings—make no mistake about that. If your citizens would be interested in these benefits, write Fairbanks, Morse & Co., Department 118, 600 South Michigan Avenue, Chicago, Illinois. Branches and service stations throughout the United States and Canada.

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Diesels

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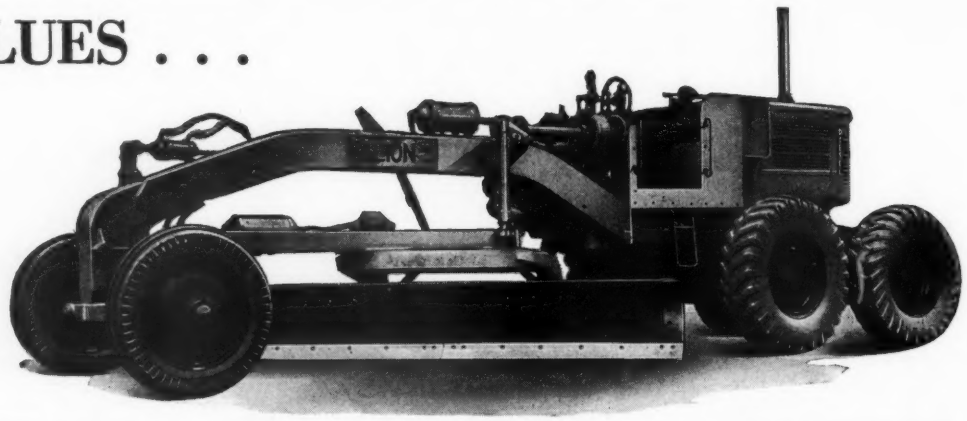
ALL HAVE HYDRAULIC CONTROL



No. 101 Motor Grader—a big sturdy unit for the toughest kind of blading work in new road building and maintenance. Equipped with either a 66½ HP diesel or 64 HP gasoline engine and tandem drive only. Has many features for low-cost performance day after day.

Bulletin No. 253

No. 201 Motor Grader—for moderate duty. Identical in design and construction to the No. 101 except for power, weight and wheel equipment. Either a 50 HP diesel or 46 HP gasoline engine and either single or tandem drive. Like the No. 101, this unit has an extreme range of blade adjustment for blading in every position.

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No. 401 Motor Grader — for general maintenance. A lightweight machine with an International IU-4, four-cylinder, 31 HP gasoline engine mounted over rear axle providing the utmost in vision and traction. Has sufficient blade pressure to give splendid results under ordinary blading conditions. ***Bulletin No. 255***

We will be glad to receive your inquiry.

The No. 201 motor grader for moderate blading in road construction and maintenance is shown above. Next below is shown the big No. 101 motor grader in bank-cutting position. Both units have a wide range of blade adjustment for any condition.

Shown below is the lightweight No. 401 which is an ideal machine for general maintenance work in townships, counties, cities and villages. Isn't it a clean cut and nice-looking unit? You'll like this low-cost grader.

The Galion Iron Works & Mfg. Co.

Main Office and Works:

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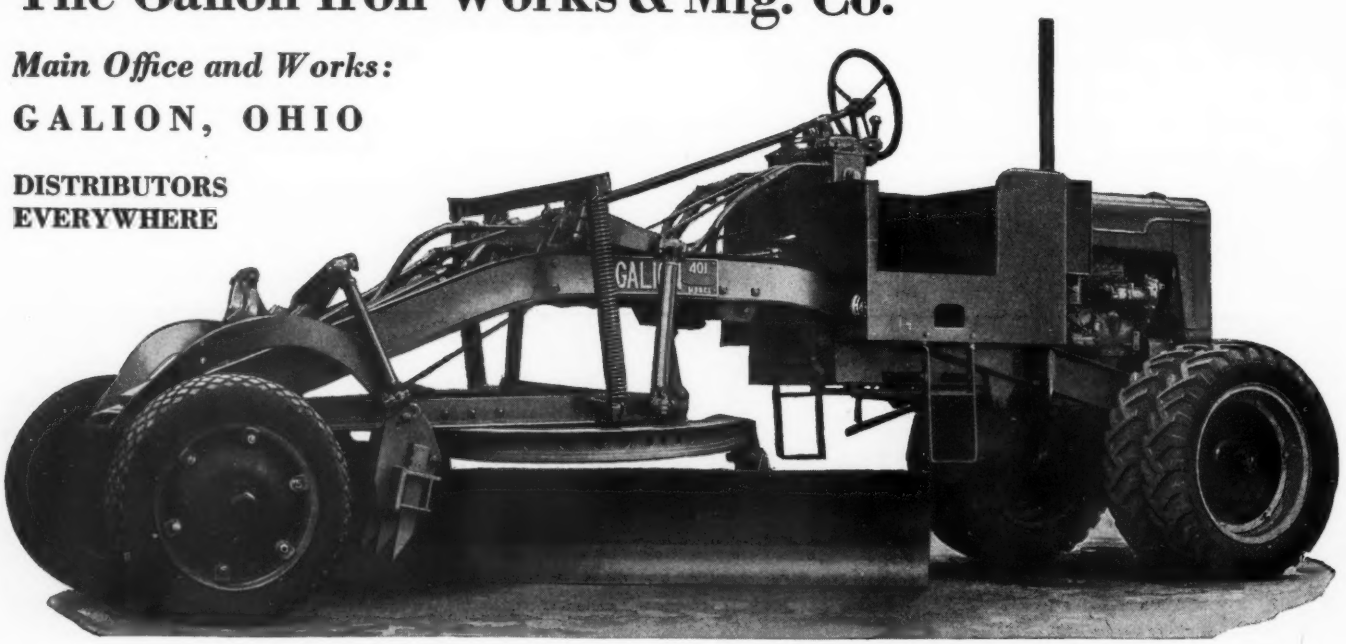

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Readers' Service Department

These booklets are FREE. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete

19. Pozzolith insures tight, smooth concrete walls, but permits the use of low water cement ratio, and saves about 20% on cement. Also admixtures for better patching and repair of concrete. Catalog and concrete estimating tables. Master Builders Co., 7016 Euclid Ave., Cleveland, Ohio.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

33. Pocket manual of concrete curing with calcium chloride. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, N. Y. C.

36. "Wyandotte Calcium Chloride and its use in Portland Cement Concrete," a booklet covering the subject of curing concrete pavements, structures, etc., giving complete specifications for surface and integral curing. Published by the Michigan Alkali Co., 60 East 42d St., New York, N. Y.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Concreting in Winter

46. "Cold Weather Concreting" is a useful booklet containing valuable data on winter concreting methods. Illustrated. Sent free by Lone Star Cement Corp., Room 2202, 342 Madison Ave., New York, N. Y.

Dirt Moving Efficiency

65. "Dirt Moving," is a new 32 page booklet illustrating the use of Trac Tractors as a source of money-making power for bulldozers, bullgraders, wheel scrapers, fresnos, graders, dump wagons, tampers, etc. 24 pages of action pictures, directions, etc. Sent promptly by International Harvester Co., 180 No. Michigan Ave., Chicago, Ill.

Distributors, Bituminous

67. Etnyre Bituminous Distributor. The "Blacktopper" units are fully described and a lot of valuable information on procedure and charts showing amount of material required. 24 pp. E. D. Etnyre & Co., Oregon, Ill.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches—for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

71. Modern Culvert Practice — a 72 page book containing valuable data and tables will be sent promptly to anyone interested in drainage by Gohl Culvert Mfrs., Inc., Newport, Ky.

Hose and Belting

87. Complete information on rubber hose and belting for all types of contracting and road building service. The Government Sales Department of the Goodyear Tire & Rubber Co., Inc., Akron, Ohio.

Mud-Jack Method

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrations.

112. Booklet describes Colprovia Process-dense type cold asphalt paving for non-skid, economical surfacing of roads, streets and airports. Well illustrated. Write Colprovia Roads, Inc., 183 East Main St., Rochester, N. Y.

Paving Materials, Brick

116. Standard specifications for vitrified brick pavements and brick parking strips and gutters, as adopted by the American Public Works Association. Also standard specifications for bituminous filled brick pavements adopted by the American Association of State Highway officials. If you contemplate using brick for paving, you should have a set. National Paving Brick Ass'n, Washington, D. C.

Pavers and Mixers, Bituminous

118. Tamping Leveling Finisher. This handles bituminous mixtures, laying a smooth mat without forms, tamping and compacting to desired grade. Description of construction methods. Barber-Greene Co., Aurora, Ill.

119. Bituminous Mixer. Exact control by volumetric proportioning. Continuous mixing and large capacity. The Barber-Greene mixer can be used as a unit of a travel plant or as a central plant. Excellent and instructive book on request. Barber-Greene Co., Aurora, Ill.

Paving Materials, Gutters

120. "Brick Gutters and Parking Strips." A study dealing with the problems faced in the proper construction of gutters and how they can be overcome. Covers design, construction and results. Well illustrated. Issued by the National Paving Brick Ass'n, National Press Building, Washington, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from 1½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

125. Homelite portable, self-priming, centrifugal pumps in sizes from 2" to 3" are fully described and illustrated in new folders. Homelite Corp., 2404 Riverdale Ave., Portchester, N. Y.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenance

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalog 200 issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

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Use the coupon on Page 55 or send your request direct, mentioning Public Works Magazine.

Readers' Service Department

129. New bulletins illustrate and describe the latest line of Littleford Utility Spray Tanks, Traf-O-Liners, Street Flushers and Kettles. Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3846 No. Palmer St., Milwaukee, Wis.

137. New bulletin describing in detail the new Huber Road Rollers will be sent promptly on request by the Huber Mfg. Co., Marion, Ohio.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

139. "Iron Roll" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. Hercules Co., Marion, Ohio.

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.—4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principles and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 24 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

152. The Columbia Alkali Corporation, will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York City.

153. "Rock Salt for Stabilized Roads" is a handy, illustrated booklet telling how to construct and maintain salt-soil-stabilized roads. Sent on request by International Salt Co., Scranton, Pa.

154. "Soil Stabilization with Tarvia"—An illustrated booklet describing the steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Company, 40 Rector St., New York, N. Y.

Street and Paving Maintenance

Steel Forms

160. Complimentary Bulletin S-19-F, issued by The Heltzel Steel Form and Iron Co., Warren, Ohio, contains complete information on the use of steel forms for constructing concrete curbs, curb and gutters and sidewalks.

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hot-stuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

199. Aeroil "Heet-Masters" for quick heating and melting of tar, pitch, asphalt, etc., with less fuel are illustrated and explained in new catalog No. 182W issued by Aeroil Burner Co., Inc. Box 599, West New York, N. J.

Bituminous Materials

202. The maintenance of all types of roads and streets is the subject of this 52 page booklet which will be sent on request by The Barrett Co., 40 Rector Street, New York, N. Y.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

211. A complete booklet on dust control titled. "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York, N. Y.

Sanders

270. Galion's new, inexpensive sander for quickly spreading sand, stone dust, cinders, chips, rock salt, calcium chloride, etc., is described and illustrated in a new circular which will be sent on request by Galion Iron Works & Mfg. Co., Galion, Ohio.

Sprayers

280. Cutback sprayers with new "single unit safety control" and full control of all spraying operations from the nozzle are described and illustrated in new bulletin issued by Aeroil Burner Co., Box 599, West New York, N. J.

Sweepers, Rotary

300. "Frink Roto-Broom," a 4 page bulletin illustrating and describing a new rotary sweeper by Frink. Attaches to front of and makes a sweeper of any motor truck. Used by street and highway departments, parks, airports, playgrounds, arenas, coliseums, etc., for sweeping dust, dirt, sand gravel, cinders, leaves or snow. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Snow Fighting

Plows

349. "Frink V Type Sno-Plows" is a 24 page catalog fully illustrating and describing 8 models of V Type Sno-Plows for motor trucks from 1½ up to 10 tons capacity, 16 models of Frink Leveling Wings, the Frink Hand Hydraulic Control and the latest Frink Selective Power Hydraulic Control. Data are given for selecting the proper size V plow and wing for any truck. Issued by Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

352. "Make Icy Pavements Safe with Rock Salt" tells how to get the best results when using rock salt for ice prevention and control. 16 pages; helpfully illustrated. Sent free by International Salt Co., Scranton, Pa.

353. "Skid-Proofing Icy Roads and Streets" pictures and explains how to solve your ice problem with calcium chloride. Sent promptly by the Columbia Alkali Corp., 30 Rockefeller Plaza, New York, N. Y.

Sanitary Engineering

Aero-Filter

356. New illustrated bulletin gives complete information on design of Aero-Filters to provide high-capacity, uniform, raindrop application over the entire filter bed. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use," is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Aerators for Sewage

377. New 24 page booklet, No. 6571 describes and illustrates the Dorrco Paddle Aerator and also the Turbo-Aerator. Also contains a discussion of the activated sludge method of treatment with much interesting data and illustrations, including a section of "Useful Information." Issued by The Dorr Co., 570 Lexington Ave., New York, N. Y.

Chemicals

380. For technical data concerning the use of Diamond Liquid Chlorine, Soda Ash, Caustic Soda, Silicate of Soda and Ferric Chloride write The Diamond Alkali Co., Pittsburgh, Pa.

Cleaning Sewers

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer, Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Cast Iron Sewers

384. Cast Iron Pipe for Sewers. Cast Iron Pipe has beam strength, resistance to crushing stresses and infiltration-proof joints making it highly desirable for flow lines, force mains, submarine lines, outfalls and sewage treatment plants. For specifications write U. S. Pipe and Foundry Company, Burlington, N. J.

Chemical Treatment

385. A handbook on the application of chlorine and iron salts in sewerage treatment. Tech. Publication 177. Wallace & Tiernan Co., Inc., Newark, N. J.

Diesel Engines

386. Write Dept. 118, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill., for data on how the installation of F-M diesels has lowered taxes and made it possible for many communitines to pay for their improvements out of municipal power plant earnings.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from %Proportioneers, Inc.% 96 Codding St., Providence, R. I.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

Flow Meters

391. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others—and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 68th and Upland Sts., Philadelphia, Pa.

Gates, Valves, Hydrants

393. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

394. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

Grating

395. High strength reversible aluminum grating with interlocking bridges and non-slip surfaces especially designed for sewage disposal and water purification plants is described in bulletin G-1 issued by The H. J. Thelen Bronze Co., Inc., 118 Sandford St., Brooklyn, N. Y.

Hypochlorinators

396. New illustrated booklet W&T 357 describes this simple, inexpensive means of protecting small water supplies such as summer camps, hotels, swimming pools, dairies, etc., as well as for feeding chemical solutions in the water works plant. Contains typical installation sketches. Write "Wallace & Tiernan Co, Inc., Newark, N. J.

Manhole Covers and Inlets

404. Street, sewer and water castings made of wear-resisting chilled iron in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter, crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., South Bend, Ind.

Meters, Venturi

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corrosion, clogged pipes, etc. Write Builders Iron Foundry, Codding St., Providence, R. I.

Meters, Water

407. Complimentary bulletin W529 tells all about Pittsburgh IMO water meters, "the meters that wear in where others wear out." Write Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

Pipe Forms

411. Making concrete pipe on the job ject of a new booklet just issued by Quinn to give employment at home is the sub-Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe, Reinforced Concrete

412. Literature describing the manufacture and installation of Lock Joint Reinforced Concrete Pressure Pipe for water supply lines and sewer force mains. Lock Joint Pipe Co., Ampere, N. J.

Pipe, Transite

413. Two new illustrated booklets, "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipe. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

Electric Pipe Thawer and Arc Welder

417. Ralph Fern, 2430 Boulevard Ave., Scranton, Pa., describes and illustrates a combined pipe thawer and arc welder in a new folder. Claims to be easy to operate, requiring only one man; is adjustable for any size or length of pipe; will thaw ordinary service pipe in half an hour and no welding job is too big. Write for folder today.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Pumps for Sludge

427. Simplex, duplex and triplex pumps for sewage sludge are described and illustrated in bulletin issued by Marlow Pumps, Box 566, Ridgewood, N. J.

Screens, Sewage

428. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Avenue, Chicago Ill.

Sewers

429. "ARMCO Sewers" is the title of a 48-page booklet describing the structural and other advantages of ARMCO Ingot Iron. Paved Invert and Asbestos-Bonded pipe for storm and sanitary sewers. Design data and large charts will be found helpful by engineers engaged in the design or construction of sewers. Copies will be sent on request by the Armco Drainage Products Association, Middletown, Ohio, or its associated member companies.

Meter Setting and Testing

430. All about setting and testing equipment for Water Meters—a beautifully printed and illustrated 40 page booklet giving full details concerning Ford setting and testing apparatus for all climates. Ford Meter Box Co. Wabash, Ind.

Schools, Correspondence

435. Complete courses in Sewage Disposal Plant Operation, Water Works Operation and Public Works Engineering for those who want to take advantage of the opportunities awaiting trained operators. For details write Box 8048-B, International Correspondence Schools, Scranton, Pa.

Small Septic Tanks

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 504 E. Glen St., Syracuse, N. Y.

Sludge Drying and Incineration

439. The five basic steps of: sludge preparation; flash drying; incineration; deodorization; and dust collection are explained in a new 24 page booklet, No. 6781 issued by The Dorr Company, 570 Lexington Ave., New York, N. Y., sales representatives for the C-E Raymond system of sludge drying and incineration.

440. Disposal of Municipal Refuse: Planning a disposal system; specifications. The production of refuse, weights, volume, characteristics. Fuel requirements for incineration. Also detailed outline of factors involved in preparation of plans and specifications. Morse-Boulger Destructor Co., 216P East 45th St., N. Y.

441. Full information about Nichols modern, efficient garbage and refuse incinerators now available in the Basket Grate, Continuous Grate, Revolving Grate and Monohearth types will be sent promptly by Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

442. Recuperator tubes made from carborundum (preheaters) for better incineration and "corebusters" to keep air passing through the tubes are described and illustrated in booklet issued by The Fitch Recuperator Co., Peoples National Bank Building, Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Swimming Pools

445. A new booklet "Essential Factors in the Design and Layout of Swimming Pool Systems," with data on filtration equipment, fittings, solution feeders, accessories, etc., is available from Everson Manufacturing Co., 213 West Huron St., Chicago, Ill.

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

447. 40-page Manual on swimming pools. Includes swimming and pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

Readers' Service Department

These helpful booklets are FREE. Write to the firm whose name is given, mentioning PUBLIC WORKS, or to this magazine.

Taste and Odor Control

449. "Ozone and Palatability," (Bull. 103) explains ozone and the beneficial effects of its application to water. Describes various installations and illustrates ozonating equipment. Write to Ozone Processes, Inc., 1500 Walnut St., Philadelphia, Pa.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

Trickling Filters

463. Construction details and underdrainage construction design for trickling filters. Data sheets give full information on use of Armcre filter underdrain units. Ayer-McCarel-Reagan Clay Co., Brazil, Ind.

464. 16-page booklet describes and illustrates a floor system for trickling filters; specifications for trickling filter underdrains; tests; loading data. Metropolitan Paving Brick Co., Canton, Ohio.

465. Standard shapes and details, construction data and specifications for trickling filter underdrains. Translot blocks and their use. Cannelton Sewer Pipe Co., Cannelton, Ohio.

466. Booklet contains detail section drawings of typical trickling filter installations, showing underdrain and ventilation arrangement. Specifications and illustrations. W. S. Dickey Clay Mfg. Co., 400 New York Life Bldg., Kansas City, Mo.

467. Use of "Unifilter" underdrain blocks is described and information is given on trickling filter drainage and ventilation details. How to install. National Fireproofing Corp., Pittsburgh, Pa.

468. Plans of trickling filter construction details, typical installations, specifications and other data of value in trickling filter design and construction. Bowerston Shale Co., Bowerston, Ohio.

469. "Aerodrane" underdrain blocks for trickling filters, with information on their use, installation and advantages. Bulletin on request. Universal Sewer Pipe Co., 1500 Union Commerce Bldg., Cleveland, Ohio.

Valves (See Gates etc.)

Water Works Operating Practices

491. "Soft Water for Your Community" tells by means of many interesting pictures and text the advantages of soft water to any community. Ask for a copy from The Permutit Co., Dept. G4, 330 West 42nd St., New York, N. Y.

492. "Alkalies and Chlorine in the treatment of Municipal and Industrial Water" is a new comprehensive survey filled with tables, charts, cost comparisons, etc., valuable to all who treat large volumes of water. Write Solvay Sales Corp., 40 Rector Street, New York City.

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For the Engineer's Library

Brief reviews of the latest books, booklets and catalogs for the public works engineer.

Plumbing and Public Health:

The U.S. Public Health Service has recently released Public Health Bulletin No. 256 entitled "Plumbing and Public Health," a 118-page publication containing a short chapter on waterborne diseases, a digest of related activities of other agencies, a short review of the work done under Public Health Service supervision in New York and Detroit to detect public health hazards due to faulty plumbing in Federal buildings, discussions of other investigations and of a tentative method to evaluate the results of plumbing inspections, and a resume of corrective measures which might be taken when hazards are detected. Price, $0.30.

Asphalt Specifications:

Specifications for emulsified asphalts has been issued by the Asphalt Institute, 801 2nd Ave., N. Y. Ask for Construction Series No. 53; other specifications available include Cutback Asphalts, No. 51, and Slow-Curing Liquid Asphaltic Materials, No. 52.

Aluminum Paint Manual:

In this 100-page Manual, the Aluminum Co. of America, Pittsburgh, Pa., outlines information which is a guide for the selection of proper aluminum paint for any particular service and gives directions for the most efficient methods of mixing and applying it. The recommendations are based on many years of experience in the practical use of aluminum paint and have been confirmed by the extensive investigation of the Aluminum Research Laboratories. Those interested can obtain a copy of the Manual by writing to the company and referring to this notice.

Hotel Engineering:

Hotel Engineering: Water Consumption, Costs and Savings. Issued by the American Hotel Association (New York City; price $1.00), this 32-page book is intended primarily to suggest how hotels can economize in use of water; but water works officials and water and sewerage engineers will be interested in data from 202 hotels of all sizes and geographical locations, showing actual figures of quantities of water used per available room and per occupied room, for all services including boilers, kitchen, laundry and air conditioning.

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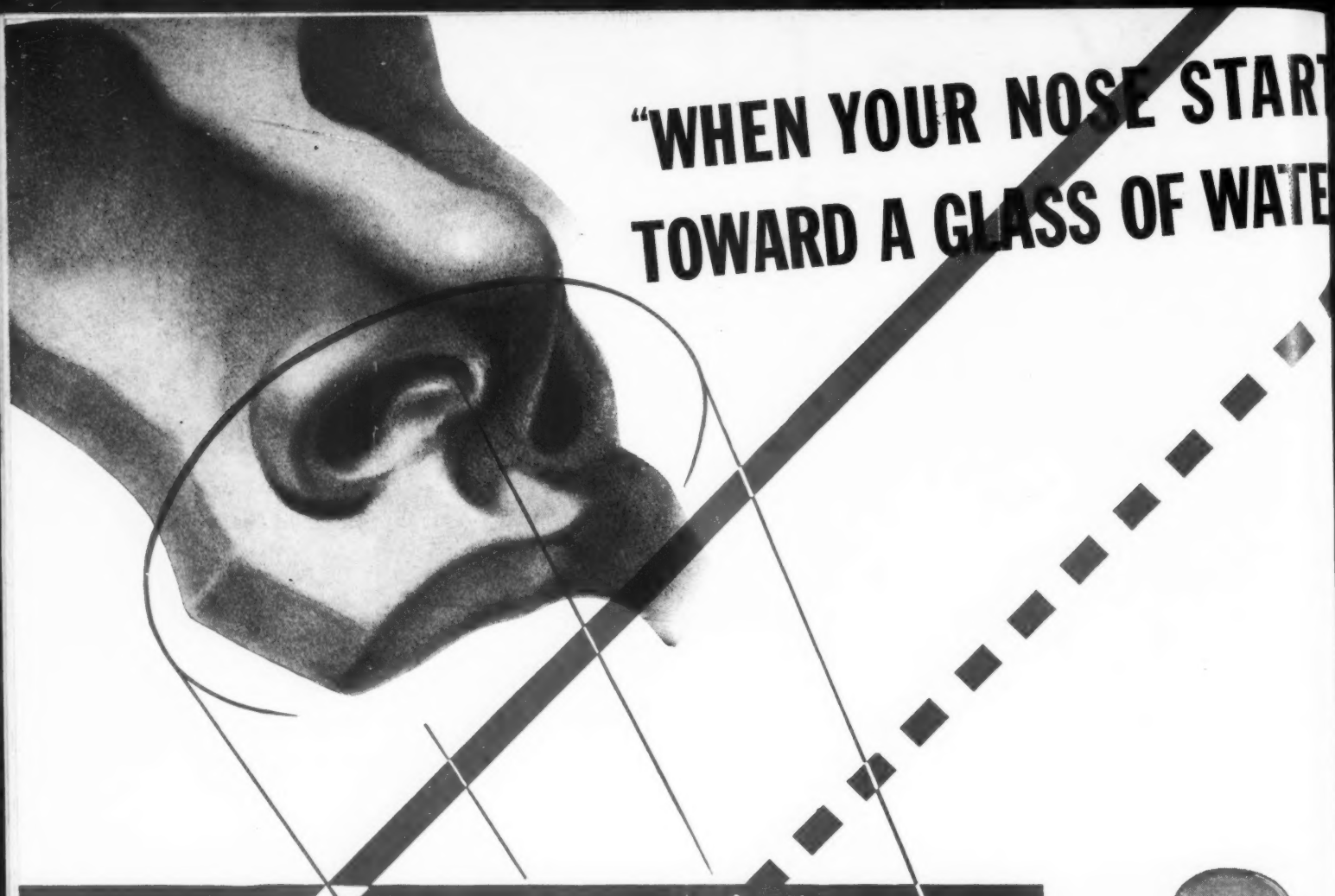

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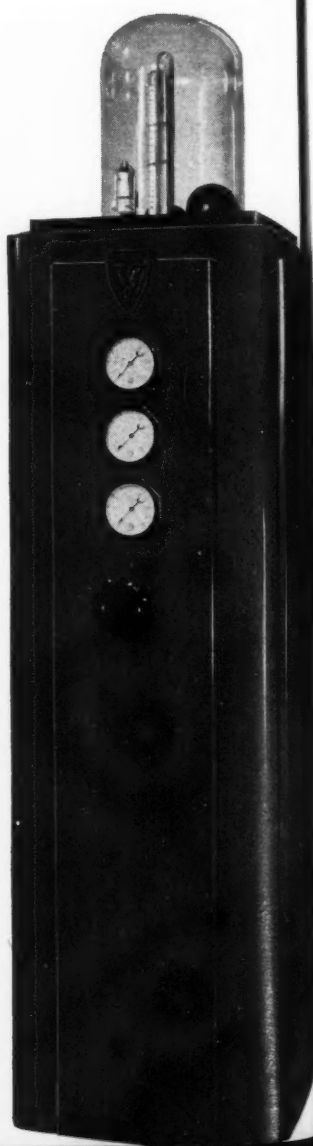
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